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Increasing Productivity of Busbars manufacturing in Switch Board Industry

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Abstract - **This research aims to increase efficiency of busbars manufacturing, which is a part of the switchboard manufacturing process. According to the recent study, the plant layout was disorganized. As a result, inefficient work flows and delays in the manufacturing process were occurring. In this study, principles of the Systematic Layout Planning Pattern (SLP) and analysis the relationship by relationship charts with the Arena program are used to improve plant layout to be more effective. The result shows that the distance was decreased from 32 meters to 19 meters ,which equivalent to 40% and production time was decreased by 7%. As a result, the productivity increased by 15%, which makes employees work faster, reduce employees fatigue, which make the busbars production rate increased and increasing the productivity in the manufacturing process as well.**

Keywords - **Manufacturing process, The Systematic Layout Planning Pattern, Arena program**

I. INTRODUCTION

Current organization management is preparing to cope with the rapidly changing situation. According to customer demand, the competitive situation in the market and higher production costs are likely to rise gradually which couldn't be avoided. However, corporate executives have understood the idea and find a method to prevent such problems and to build factories with perfect either plant layout and production plan. The plant will require a factory layout system [1]. If the plant layout is not in the system, it will undermine the facility in several respects. For example, operation safety, delays in manufacturing process, resource depletion and waste production in budget waste. Which results incorrect of the placement of equipment and the allocation of work space in the plant is not in a system [2]. There is not enough area for machine placement which affect the manufacturing process not worth the investment due to designing factory layouts several theories[3], for example, the principle of Immer (2493), Principles of Reed (1961), Principles of Apple (1977) and the principle of Muther [4].

The researcher has adopted the Design Factory Muther and used the principle of Muther which called layout the factory system "Systematic Layout Planning" (SLP) is a method for planning the plant consists of various stages (Phases) of the planned workshop (Pattern of Procedures) and set the pattern of the individual components, as well as areas in part related to the planning of the factory as the proportion and proper [5],[6]. However, since in practice it cannot be modified to experiment or process until you see the benefits are gained. So simulation will help to analyze the status of the current system and help finding solutions or alternatives (Scenario) used in appropriate situation or performance [7]. This will help reduce the risk of error or failure. It also helps to save cost and time (Maria, the 1997) [8],[9].

The researchers used ARENA program [10],[11], which helps in the simulation to find solutions to improve systems within the plant layout, such as the placement of equipment on the factory's production process with the shortest distance, minimum production time and to find ways to improve productivity [12]. Yang et al (2000) [13] has adopted a plant layout system (Systematic Layout Planning: SLP) applied in plant layout. Mill Semiconductor Wafer has presented plans for a multiple choice format. This has several purposes: 1. Maximum capacity 2. Ability to produce a maximum 3. Flexibility of layout and 4. The flow of WIP maximum efficiency. Process is used to selectively sequence analysis (Analysis hierarchy process: AHP) analysis to select the most suitable plant diagrams.

In addition, Shewale et al (2012) [12], have studied on the amount of tools and equipments in compressor production and use SLP analyzed the distances travelled between various stations. This can be the new layout and decrease the flow of material and hence resulting in reduction in waste causes increased production. While, Mahendra Singh (2012)[14], their use of SLP can be an effective stage for playing out the services to customers.

They have studied on various types of advanced and basic facility layouts. Subodh et al (2014) [15], has brought the theory of SLP used in a case study of the medium scale industry. They have discussed about the problems faced. SLP can reduce the problem in a medium scale auto ancillary company & also stated that the material handling time, labor cost, transportation cost etc.. While, Somsook et al. [16] had also applied SLP to wood furniture factory and reduced material handling distance 60.35%, material handling time 56.30% and production capacity increase 34.26%. Simulation is a compilation of the various

methods used to simulate the behavior of real systems onto your computer using the computer software to help in order to study the flow of events in different ways and to improve the software accuracy in the future.

This simulation is very popular and has been developed continuously. As a result, the simulation can be applied to a variety of industries such as industrial manufacturing, transportation, distribution, or even to provide business services, such as banks, hospitals, etc. (Kelton, et al., 2003) [8]. There are many papers studied the application of Arena programs in many industries. The application of the model to evaluate the efficiency of plant layout by the Somchat PongMani and Ekachai Tang Kanjanakul saying. (2002) [17], to improve manufacturing techniques, the layout of the factory Teeraporn Senprom and Nongnuch Rakpibookit (2003) [18] offers a way to evaluate plant layouts Adjacency-Based. Scoring and Procedures Distance-Based Scoring was not able to demonstrate productivity increases or decreases from factories because the study was not to assess the time to work the waiting time of the work piece in unloading goods out of the program to improve plant layout, so Arena is the right choice. Bringing evaluates performance results from the model that debuted Works at 2 (on a Grid Representations) takes the production system and materials handling, including a minimum figure for production, less than 18 percent and transport 34. Shoot down 51 percent. Company A is the manufacture of Main Distribution Switch Board (MDB) or the main electrical panel. The main components of the main distribution switch board include enclosure, busbars, Circuit Breaker, Meter and accessories. The busbars are the main component part inside the switchboard. It is a long copper rod used to power 1-phase, 2-wire or 3-phase, 4-wire busbars will be installed in the cabinet switch board [19] [20]. The first bus bars inside the cabinet switch board operators will go through the process to calculate the distance and the length of the busbar, measuring bar, folding bar, bending bar, cutting bar, Drilling and Pump holes bar. There are wastes in each the process. The wastes in the process have directly impact on company costs [21]. With a large amount of waste the cost is increased which less opportunity to compete or lose market share. To analyze the cause of the problem and find the solution that was so vital to the Competitiveness of the organization, particularly [22]. Thus, there is a need, building strengths to produce the data collection company. Problems encountered in the process. The delay in the production process. A route to transport items overlapping. The work flow is not in the same direction. Thus, the data were analyzed using the Relationship chart [23],[24] and Simulation in the Arena to find ways to improve the manufacturing process to increase [25]-[27].

II. RESEARCH METHODOLOGY

A. Research and gather information

1) Plant layout: The researcher used Muther's principle called "systematic layout Planning: SLP" is a method for planning the plant which consists of various stages of the planned workshop (Pattern of Procedures) and set the pattern of the individual components, as well as areas in part related to the planning of the factory as the proportion and proper.

2) Simulation: The researcher used the ARENA program, which helps in the simulation to find solutions to improve systems in the plant such as the placement of equipment in the factory's production process with the shortest distance and find minimum production time to increase productivity.

3) Collecting data: Information used to overview the company and investigates flow chart of work processes.

3.1) Overview of the Company A. The location of manufacturing bases: In this study, Busbar manufacturing processes have employed 20 people. Number of machines used in the manufacture of busbars are 5 which have functioned as follows: 2 Cutting bars machines, 2 Drilling bar machines and 3 folding bar machines.

3.2) Information flow chart of work process. Start by cutting busbars by the bar into one meter each. Then, measuring busbars size to find the drilling and the folding position marked by human labor. When the measured Bar is completed, Take into the drilling and folding bar in the position that has marked. When roll bar is finished, the next step is bar examination. Bars that don't pass inspection will be divided into two cases. The first case is bringing busbars to recast and the second case is busbars that can't be recast (sold for scrapping). Busbars that passed the inspection are sent to wipe clean and masking tape to Packing in a wheelchair waiting for transportation to the next department as shown in the Fig.2

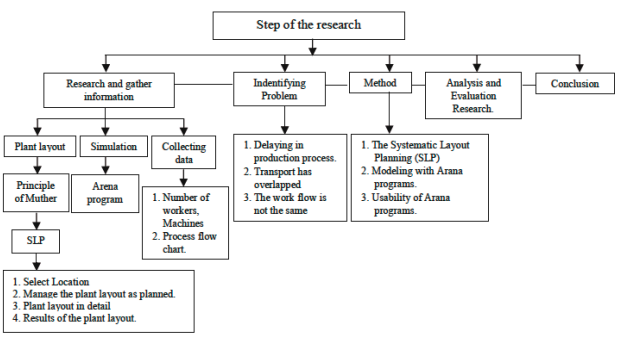

Fig. 1 The step of the research.

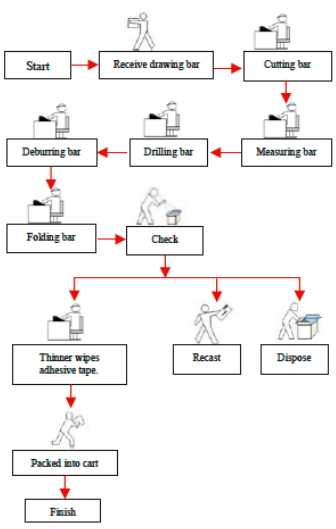

Fig. 2 The process flow chart of the process of bus bar Manufacturing

B. Identifying Problem

Overview of the Problem: The Problem of Company A is the plant layout of Company A have late working in the production process because transportation has overlapped, workflow is not in the same direction. It causes a negative effect on the plant in many respects, such as safety at work, delays in the production process, including a loss of resources and budgets to produce waste. This is a result of the incorrect placement of equipment and the allocation of work space inside the plant is not a system and an insufficient machine placement area Affects the manufacturing process was not worth the investment. The current layout plan of the plant is shown in the Fig.3

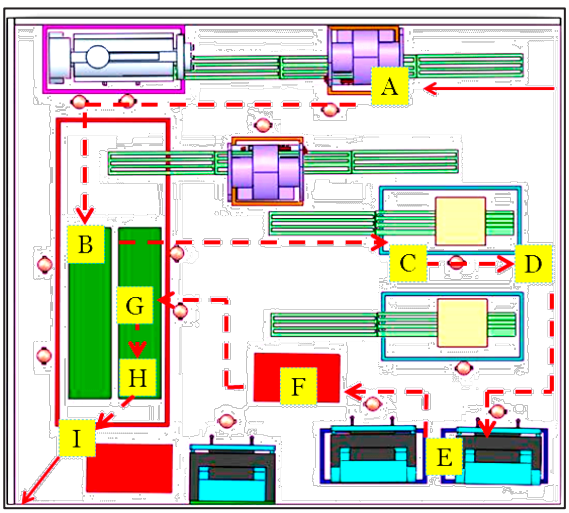

Fig. 3 Factory layout of busbars process

The Fig.3 shows the existing plant layout which has busbars department, Cutting bars(A), Measuring bars(B), Drilling bars(C), Remove sharp(D) , Folding bar(E), Inspection(F), Wiped thinner(G), Glued(H), Packed into cart(I). These departments are arranged in non-sequential manner, hence wastage of time for movement is more. So its effects on productivity of organization.

C. Method

From the problem the researcher has adopted. Relationship chart and Arena program simulation are used to find solutions to improve systems in the plant such as the placement of equipment on the factory's production process with the shortest duration and the lowest production in order to guide the improvement of the productivity.

1) The Systematic Layout Planning (SLP) Systematic layout planning (SLP) is an organized approach to layout planning depicts the stages in the process. It shows process flow charts of the material through the plant. An operation process chart depicts the operations, inspections and the flow of the process. In the operations process chart. The SLP has been found to improve spatial distances between facilities (machines, between workstations and between departments) and also improve the flow of maternal through the plant. Thus, the cost of material handling is reduced significantly, As a consequence, less material handling time is needed, workers move faster and the overall productivity increases. You can find out more from the theory of Muther [4].

2) Modeling with the Arana programs. Simulation is a compilation of the various methods used to simulate the behavior of real systems onto computers by using a computer program to help in order to study the flow of events in different ways. The retention and to analyze ways to improve the accuracy of the software in the future. Arena is a software-based modeling and simulation. To demonstrate the problem, the consequences - good and bad, to get the best option before making a real treat can also simulate a variety of formats to assist in the analysis and evaluation of the work happened to be the most effective. This reduces the risk of disrupting the work. Reducing the cost of operations. Cause resource utilization and cost-effectively. Simulation modeling in Arena Simulator: The model of the process was developed using an Arena program to begin the experiments, all the values are taken as constant. The processing time in the departments is constant with the average value of processing time from time study was used. Every resource is fixed with a quantity of one each. The simulation is first carried out with constant system, in which the bottleneck was noted and removed or eliminated by increasing the number of resources. An optimal number of resources were worked out for achieving. In modeling situations can be studied more from Kelton, et al. [8]

3) Usability of the Arana programs. Arena is a popular program used widely for modeling, simulation, and conduct experiments as well. Simulation was conducted to test the idea on a computer to study the behavior of the system and will lead to an approach to analyze the system more efficient. This research used the Arena program version 14.7.

The Arena window shown in Fig.4, Starting from *step A*, a user begins with the blank Arena window depicted on the left side of the Arena window is the Project Bar,select "Basic Processes," Drag a Process module from the Basic Process into the model window, drag it to the right of the Create1 in *step B*. Basic Processes as shown, these options include create, dispose, process, decide, batch, separate, assign, and record. These are the basic pieces used to build a simulation model in the Arena. Users can change the name of the process. It may be named after the process of work. In the process, users add Name, Resource will be selected "Seize Delay Release," (Its meaning, that meaning that will be a delay while the process is taking place, and then the entity will be released.)

Step C selects the "Process" in Basic Processes and drags it onto the Arena window. Connecting appears between Create and Process click the object to connect menu item or the connect toolbar button to draw a connection. (In build Process module, if there has multiples Process enters each Process to connect.)

Step D selects the "Dispose" in Basic Processes and drags it onto the Arena window. It is the end of process flow. It will be linked to the process1 that was previously inserted in Fig.4

Step E selects "Run" setup starts the simulation run by click "Go" button on the toolbar or click the "Run" to "Go" menu item to complete runs of Arena program.

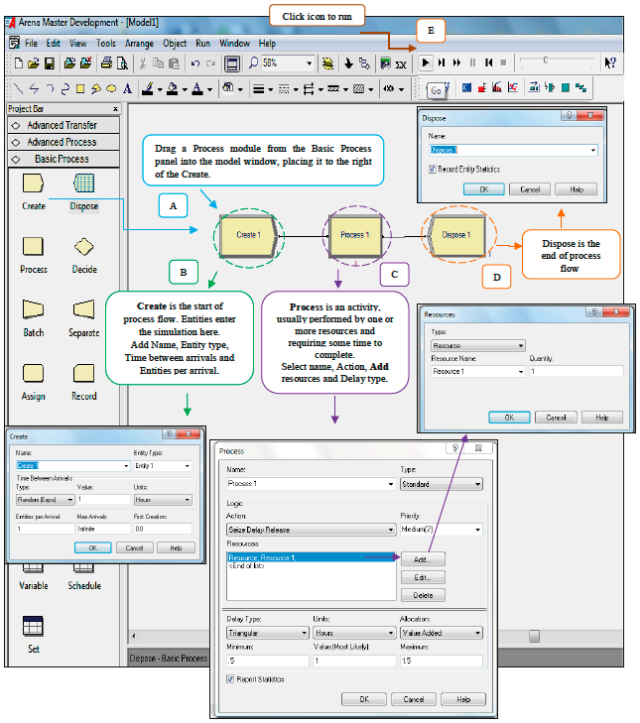

Fig.4 Display window of command in Arana programs

III. ANALYSIS AND EVALUATION RESEARCH

Work Measurement, which used to study the processes to improve the busbars manufacturing processes. The data shown in Table 1.

TABLE I
THE FLOW OF THE BASBAR PROCESS

THE FLOW OF THE BASBAR PROCESS					
Employees (Person)	Production plan				Work process
	Current	Type 1	Type 2	Type 3	
	Time (Sec)	Time (Sec)	Time (Sec)	Time (Sec)	
2	20.45	20.45	20.45	20.45	Lift the cutting busbars
1	5.13	5.13	5.13	5.13	Cutting bar
2	16.92	10.12	9.84	2.59	Moving from the cutting bar to wait measure bar.
4	19.48	12.63	10.66	4.24	Moved from start to table measure bar.
1	99.71	110.03	112.47	118.37	Measure bar
1	16.63	6.24	12.47	15.59	Move to drilling bar.
1	26.92	26.92	26.92	26.92	Drilling bar
1	3.90	3.90	3.90	3.90	Moving from drilling bar to remove sharp.
1	3.47	3.47	3.47	3.47	Remove sharp
1	12.66	8.44	7.59	6.75	Moving from remove sharp to Folding machine bar.
2	17.79	17.79	17.79	17.79	Folding bar
1	8.23	4.12	4.12	5.49	Moving from remove sharp to Check.
3	16.34	16.34	16.34	16.34	Check
1	6.13	4.08	3.06	5.11	Moving from Check to Wipe thinner.
2	5.12	5.12	5.12	5.12	Wipe thinner
1	6.34	6.34	6.34	6.34	Moving from Wipe thinner to gluing.
1	31.59	31.59	31.59	31.59	Gluing
2	17.84	17.84	17.84	17.84	Packed into the cart
Time (Sec / piece)	334.65	310.55	315.08	313.03	

From collected data to study the function chart in Table 1 shows information about the number of employees, the duration of each production manufacturing process and time processed. By the period of the busbars production plan in current can approximately produce 334.65 seconds per piece. Busbars production plan improvements type 1 can produce 310.55 seconds per piece. Production plan improvements type 2 can produce 315.08 seconds per piece and production plan improvements type 3 can produce 313.03 seconds per piece.

Design plant layouts of relationships at 3 types.

The Fig.5-8 shows the comparison flow between the busbars production plan in current and busbars production plan to improve its have 3 types.

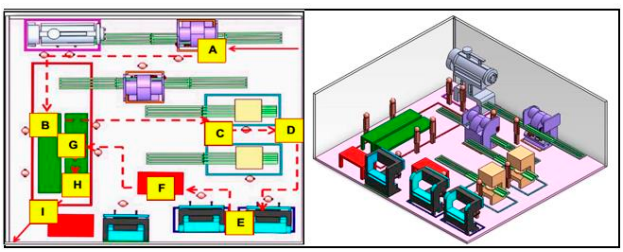

Fig. 5 Busbars production plan in current

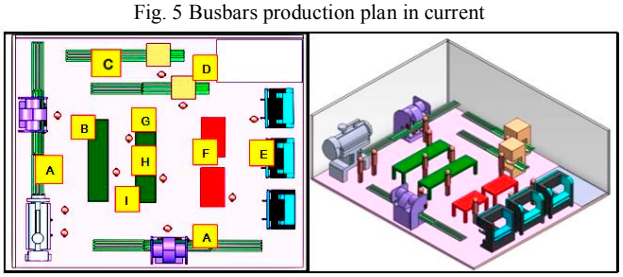

Fig. 6 Busbars production plan improvements type 1

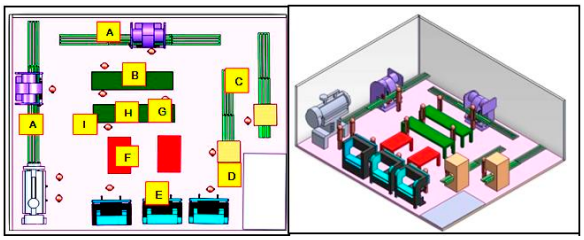

Fig. 7 Busbars production plan improvements type 2

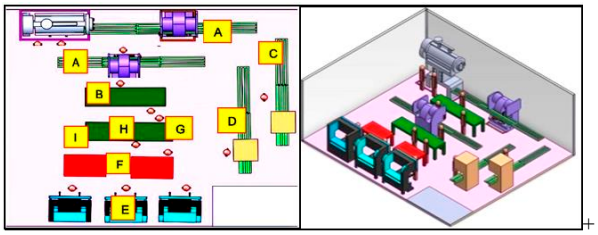

Fig. 8 Busbars production plan improvements type 3

The Fig.5-8 Show existing plant layout which has a department, Cutting bar(A), Measuring bar(B), Drilling bar(C), Remove sharp(D) , Folding bar(E), Inspection(F), Wiped thinner(G), Glued(H), Packed into the cart(I).

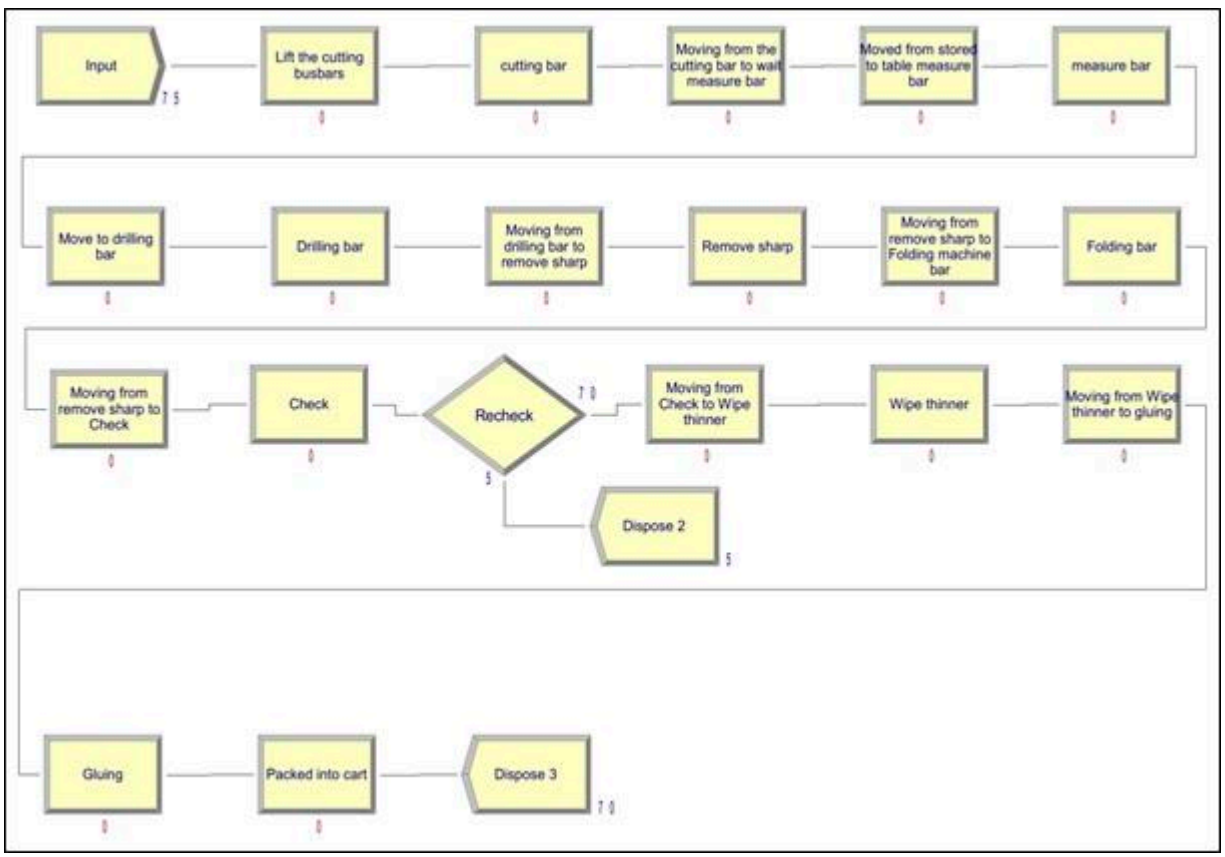

Fig. 9 Arena model of a busbars manufacturing process in current

Simulation Modeling in Arena Program*:* The model of the process was developed using Arena Program as shown in the Fig. 9 to begin the experiments; all the values are taken as constant. The processing time in the departments is constant with the average value of processing time from time study was used. The process of the busbars manufactures start from process of measuring the size to find the drilling and the folding position which be marked by human labor, when the measured bar is completed, take the busbars into the drilling and folding bar in the position that has marked in the drawing. When, folding bar finished, the next step is busbars examination. Bars that don't pass inspection will be divided into two cases. The first case, bringing busbars to recast and the second case, busbars that can't be recast (sold for scrapping). Busbars that passed inspection are sent to wipe clean and masking tape to Packing in a wheelchair waiting for transport to the next department. Arena model of a busbars manufacturing process.

Results of research indicate that from data collected and brought to in the simulation Arena program and the processing of the application can be summarized as follows. The volume of production in the manufacturing process can currently produce 75 units per day. Quantity of manufacturing from the solutions 1, the solutions 2 and the solutions 3 can produce 89 units per day, 84 per day and 78 pieces per day, respectively as shown in Table II. It is shown that improvement type 1 is most appropriate because it have a highest production rate, which is 89 pieces per day.

TABLE II
THE OPERATIONS AND PRODUCTION RATES OF SLP AND ARANA PROGRAM.

List	Distances (m)	Time (Sec/piece)	Production rate (Pieces/day)
Current plant layout	32	334.65	75
Plan improvement 1	19	310.55	89
Plan improvement 2	20.5	315.08	84
Plan improvement 3	20	313.03	78

Operating results from the analysis of the results by the Arena programs.

The results of the analysis using the Arena programs and evaluate alternatives of and busbars production plan to improve, as shown in Fig.10

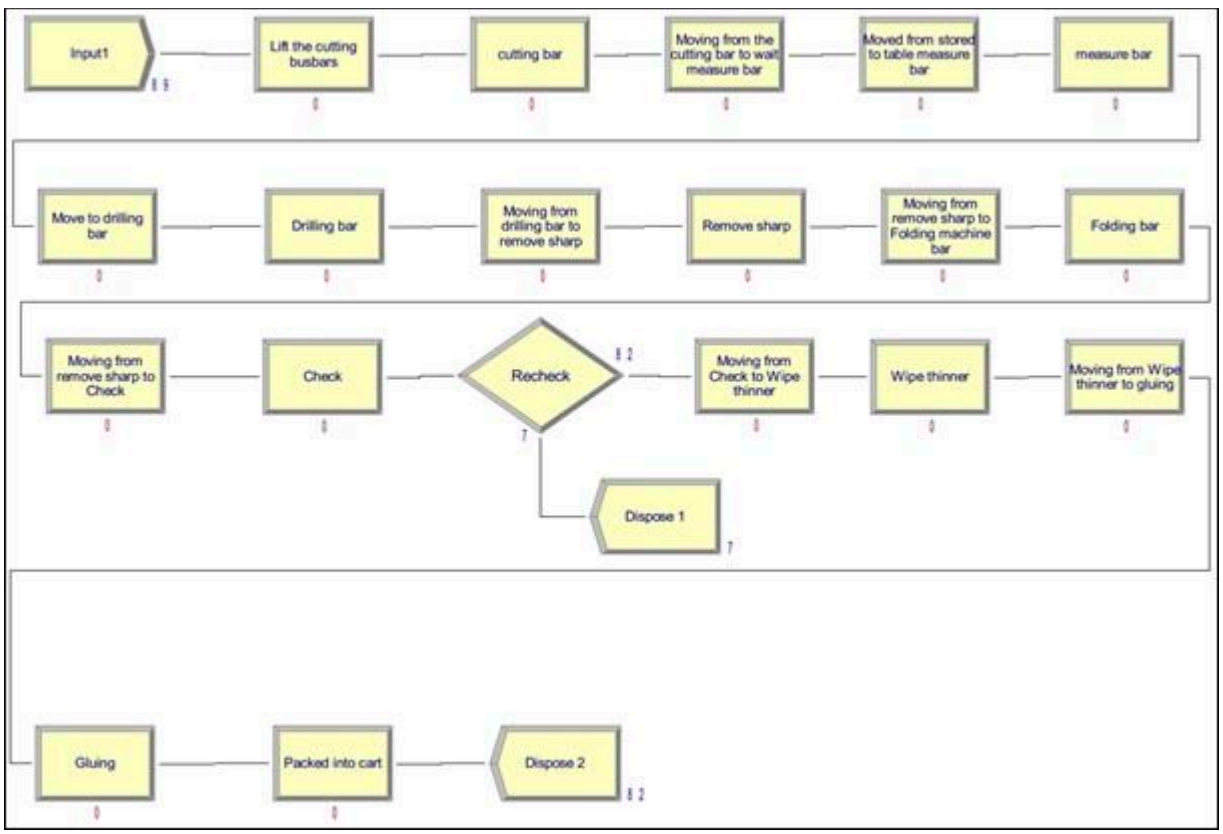

Fig.10 Arena model of a busbars production plan improvements type 1

From the production layout created according to the principles planning in the Systematic Layout Planning Pattern (SLP), the most appropriate is the plant layout improve 1. From the measuring the motion of one department to another one department as shown in Table2. The currently distance in the plant layout is 32 meters. To improve the movement and the position machines, the distance of the plant layout improved in the type 1 is 19 meters which is reduced by 13 meters. Since the distance of movement in work reduced, it makes the movement of an employee decreased and when the distance to the moving of the production process decreased, it will result in the duration of the production process to reduce as well.

IV. CONCLUSION

The results of the studied information found that problem is a disorder of the plant layout. As a result, the flow has inefficient of the workers movement and delays in the production process. In this research the principle of a systematic plan (SLP), work study and analyzing the relationship by relationship charts method is used to improve plant layout to be even more effective. The results of the improved flowchart have selected plant improvement number 1. The recitative has a total length of 19 meters, a period of production is 310.55 seconds and maximum production rate from the evaluation of Arena

programs is 89 pieces per day. It can reduce the moving distance and time period in the production process which allowing employees to work faster, reduce their fatigue and increase busbars production rate and efficiency in the production process.

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