A Study on the Cycle Time of an Assembly Workstation using Application of Arena Simulation Software in a Furniture Industry

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Abstract

Cycle time variation is a metric and philosophy for continuous improvement with the aim of driving down the deviations in the time it takes to produce successive units on a production line. It supports organizations' application of lean manufacturing or lean production by eliminating wasteful expenditure of resources.. Although it is often used as an indicator of lean progress, its use promotes a structured approach to reducing disruption that impacts efficiency, quality, and value. ARENA simulation on the other hand Arena is a discrete event simulation and automation software that allow user to builds an experiment model by placing modules (boxes of different shapes) that represent processes or logic. Connector lines are used to join these modules together and to specify the flow of entities. While modules have specific actions relative to entities, flow, and timing, the precise representation of each module and entity relative to real-life objects is subject to the modeller. This study was conducted in the assembly workstation of a headboard, the upper part of every bed with a unique design. This study was done in the AX Furniture, Muar, Johor Darul Takzim using interview, observation on the production department and ARENA simulation. Observations were made by studying each element of motion film recorded by video recorder. The research was done in order to identify the cycle time of the headboard assembly process and to increase the efficiency of the cycle time of the headboard assembly itself. Results from this study may help to increase the efficiency of the cycle time concept in a furniture industry.

Keywords
Cycle time, ARENA simulation, assembly, headboard, manufacturing

1.0 Introduction

1.1 Research Background

Cycle time is a measure of the time (minutes, hours, and seconds) required for a certain number of steps in a process to be completed, from start to finish, as defined by the team. A cycle time analysis is any method that collects and analyses time data for a process to improve the total process or system (V. Balasubramanian, 2015). It is an analysis of a worker's performance against time standard. Time studies are normally performed on short repetitive production type of tasks. ARENA simulation is a computer integrated software that can be downloaded through internet connection that focuses on making a virtual simulation, process, que, idle and calculate a process related result. ARENA software brings the power of modelling and simulation to business process improvement. Typically, any process that can be described by means of a flow chart can be simulated with ARENA. (Khalid S. Al-Saleh, 2011)

1.2 Problem Statements

Cycle time plays an important role in keeping the production and process up to the demand and the supply. (Duran, 2015). However the time cycle connects directly to the efficiency of the production and process of which a particular process is achieved. Cycle time refers to the time of which a process of assembly, production, application, and movement from starts to finish. (Top, Y. 2015). Inefficient cycle time may produce a large numbers of idle, bottleneck and que in the production causes thousands of pains in the operations. (Savona, 2015) The bottleneck effect is a problem faced by the production in which a product assembly is station A is waiting to be proceed in station B due to the fact that station B take a much longer time to finish assembly and vice versa (Cochran, and David S, 2016).

2. Literature Review

2.1 Introductions

The literature review identifies the seminal historical contributions, outlines the state of knowledge, and justifies the novelty of the article's contribution. The literature review should be based on refereed journal articles to the extent possible, (A. Musa, 2013)

2.2 Cycle Time

According to S. Santosh Kumar (2014), cycle time is the time between commencement and completion of a process, therefore, in a customer call centre, the cycle time for a customer phone call may be the time difference between answering the call and call completion. In a manufacturing company, involved in large capital products, the cycle time may similarly be the time from raw material receipt through to the time the item of production finishes final inspection. The following actions may reduce the job cycle time, and are relatively easy to take: (Rakesh Dhake, 2014)

(1) Lower the WIP level in the factory: The most effective way to lower the WIP level in a factory is through capacity expansion. Another solution is to slow down the pace at which new jobs are released into the factory.. An alternative is to accelerate the progresses of jobs that are almost done. (Rakesh Dhake, 2014)

(2) Shorten the queue lengths, especially before bottleneck machines However, bottlenecks may shift, and therefore should be detected continuously. (Rakesh Dhake, 2014)

(3) Control the delay of jobs: A delayed job means it spent more time than expected in the semiconductor manufacturing factory. (Rakesh Dhake, 2014)

2.3 ARENA Simulation

In 1993 SIMAN and CINEMA (simulation languages) were combined into a single tool: Arena (http://www.erlang.com.br/arena.asp). This tool is a simulation environment consisting of module templates, built around SIMAN language constructs, as well as other facilities and the CINEMA animation package (Altiok and Melamed, 2010). Thus, when an Arena model is created it is implemented in SIMAN code which is then compiled and run without any need to write programming code. SIMAN consists of blocks and elements. Blocks are basic logic constructs that represent operations (e.g. seize block). The purpose of the ARENA software is to help a vast community of simulation practitioners to gain access to advanced modelling capabilities to address complex problems. The simulation tool addresses some important issues related to model construction. (Antonio Vieira, 2010)

3.0 Research Methodology

3.1 Introduction

Research methodology is important to make sure the research is done systematically according to the plan so that the objectives of the research can be achieved. This research was done using the qualitative method to gain the result in order to attain the research objective. Table 3.1 shows the research framework that has been planned by the researcher.

3.2 Reseach Sample and Population

The research focussed on the asemmbly line of the headboard units in the assembly line of the AX Furniture. The interveiw, observation and data collection is done with the helps of human resources manager and production

manager of the AX Furniture.Figure 3.2 shows the assemly departent of which the observation and video recording is done inside the factory. From the picture, the process of mnufacturing flows from Station A to ZStation E

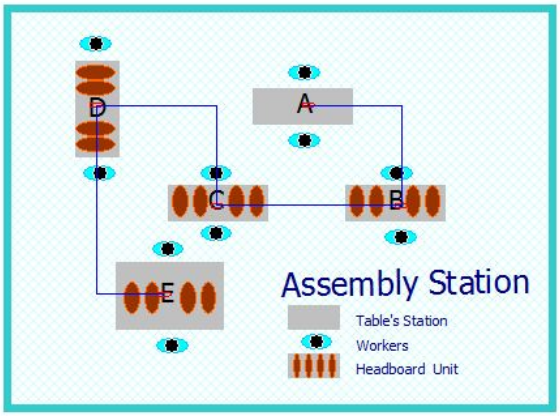

Figure 3.2 the assembly station of headborad production in AX Furniture

3.3 Data Collection

The data collected from this research is by using an interview with the Human Resources Manager and Production Manager of AX Industry. The observation has been done in a production line of headboard units since the production line is much manageable by the researches because it was a little bit smaller compared to the other production line. Following procedure is used for motion study analysis in this work,

• Recording of motion film is done by using high definition handy-cam in the .MPEG file format.
• Motion films in .MPEG format are analyzed by using Windows Movie Maker, the inbuilt video editing software from Microsoft in windows operating system at 0.125X running speed.
• At this low speed it is easy to examine and analyze body motions while working at the workstation

The data collected from the visit is then converted and coded into the ARENA simulation software to be valued, reviewed and producing the results that consist of vital data toward the study. After the interview, the conversation is rewrite in the report. Every single question and answer has been recorded and typed in the report to make sure the any content of the interview was not missed. The video recorded by is the being interpreted to attain critical data of cycle time and process flows. The data from the software can be directly obtain once the data and the arrangement of modules and element in the software is complete and correct. The vital result such as queue and waiting time will was then compared to different attribute and sets of simulations.

4. Results and Discussions

4.1 Introduction

Chapter 4 is a collaboration of the study of which to serve as the elaboration of results and findings from the study and can be used to determine the objective whether it is qualified or not. To make things easy and compact, the results and findings will be shown and presented in terms of charts, tables, pictures and graph.

4.2 Data Collection

4.2.1 Process Chart of Headboard Units

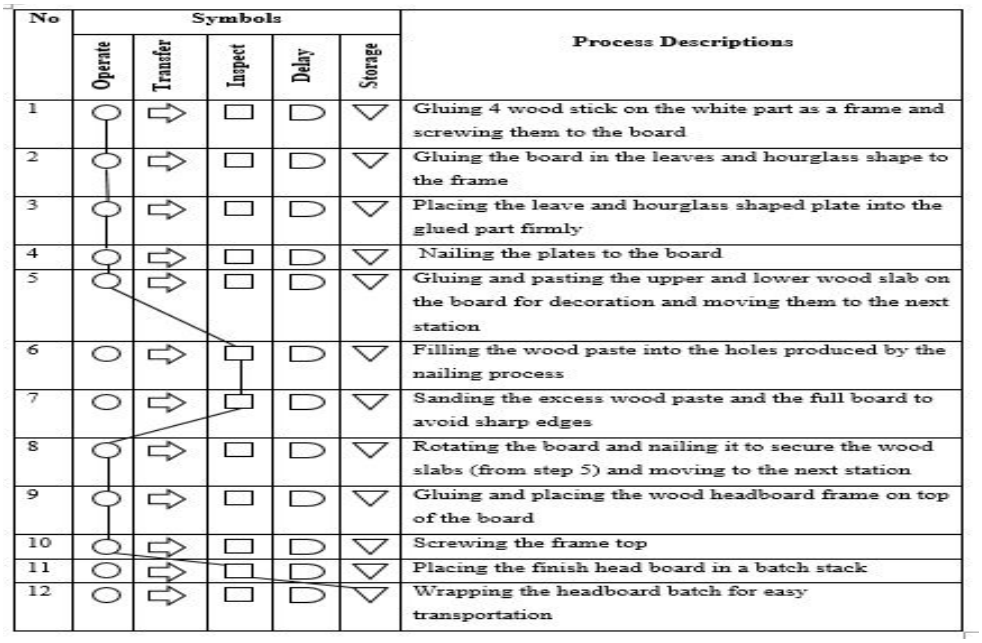

Figure 4.2 Process Chart for the Headboard Manufacturing Based on Processes.

4.2.2 Time Cycle Observation of the Headboard Assembly

Table 4.1 Time Cycle of Headboard Manufacturing Based on Processes

Steps	No of workers	Station	1st Record (minutes)	2nd Record (minutes)	3rd Record (minutes)	Average (minutes)
1	2	A	2.97	2.87	2.92	2.92
2	2	B	0.7	0.67	0.7	0.69
3	2	B	0.4	0.33	0.42	0.38
4	2	B	0.8	0.82	0.83	0.82
5	2	B	4.17	4.23	4.12	4.17
6	2	C	2.05	2.0	2.02	2.02
7	2	C	2.25	2.28	2.33	2.29
8	2	C	0.25	0.3	0.25	0.27
9	2	D	1.73	1.72	1.81	1.75
10	2	D	0.98	0.95	1.0	0.97
11	2	E	0.43	0.45	0.48	0.45
12	2	E	1.05	1.08	1.07	1.07
Total Time (minutes)			**17.78**	**17.7**	**17.95**	**17.81**

Table 4.1 measures the cycle time of the headboard assembly based on the processes of manufacturing. Steps 5 takes the longest time to finish and steps 2 takes the shortest time.

4.2.3 Graph of the Cycle Time Based on the Processes

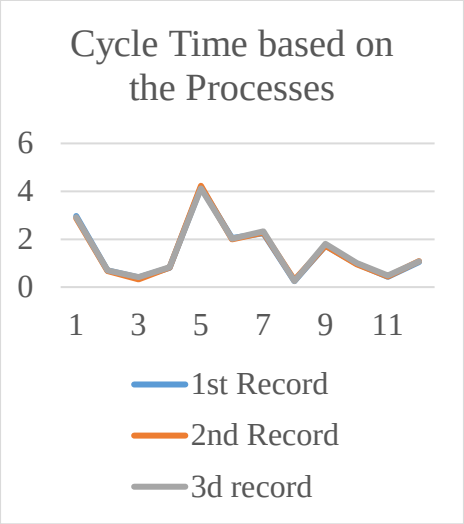

Figure 4.3 Graph on Cycle Time Based on the Processes

Based on the table form Figure 4.2, a graph was then constructed. Figure 4.3 is the graft of cycle time against the processes. From the graph, it shows that process 5 which is placing the wood slab on the upper and lower part of the board, one of the last process in Station C has the highest cycle time to be finished. Process eight which was nailing the board to secure the wood slabs on the other hand, show the fastest cycle time to be finished.

4.2.4 Simulation Model Development Based on the Processes of Assembly.

The data from the previous observation, charts, tables and graph was the codded into the ARENA software. In this headboard assembly process the modules, a character of process was placed on the ARENA canvas. The modules are the characters of which the simulation is held. There are several modules in which are shaped differently to distinguish their purposed. In this research however, it only uses creates, processes, station, and disposed. Figure 4.4 shows the arrangement of simulation from the headboard assembly that have been coded into the software. A create modules is an essential characters in most of the use in the ARENA as it depicts the starts of whatever you are simulating such as, transportations, process, packaging, flows, reports, navigate or in this case, processes. The process module depict the process of which in this case, the manufacturing of the headboard. The station modules serve as a station barrier for each process. On this case, there are five station which have been stated previously and the dispose module set up as the end of the simulation flow.

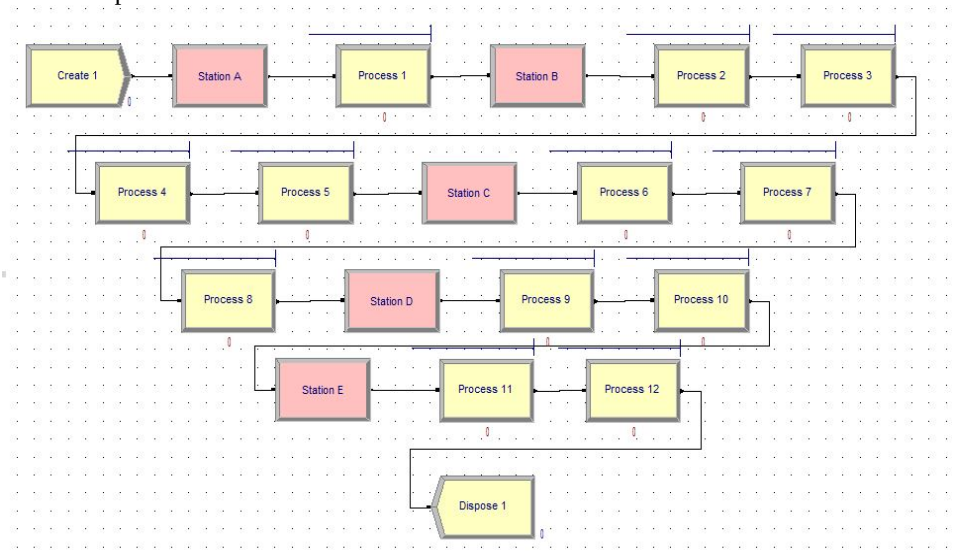

Figure 4.4 ARENA Simulation on Headboard Assembly Based on the Processes

Figure 4.5 shows one of the result generate by the simulation offer it is ran. The longest waiting time from the result is shown at the figure was on sixth process that valued up to 102 minutes. The shortest queue time on the other has

was on the process twelve which is 34 minutes. The longest and shortest queue time was measured on every for every 20 headboards produced.

Waiting Time	Average
Process 1.Queue	51.6545
Process 10.Queue	55.2937
Process 11.Queue	41.7619
Process 12.Queue	34.1987
Process 2.Queue	62.9941
Process 3.Queue	48.6190
Process 4.Queue	59.1561
Process 5.Queue	102.30
Process 6.Queue	122.41
Process 7.Queue	103.42
Process 8.Queue	75.0982
Process 9.Queue	58.3056

Number Waiting	Average
Process 1.Queue	2.8991
Process 10.Queue	3.1034
Process 11.Queue	2.3439
Process 12.Queue	1.9194
Process 2.Queue	3.5356
Process 3.Queue	2.7288
Process 4.Queue	3.3202
Process 5.Queue	5.7418
Process 6.Queue	6.8704
Process 7.Queue	5.8044
Process 8.Queue	4.2149
Process 9.Queue	3.2724

Figure 4.5 Queue and Number Waiting Report by ARENA Simulation

The number of waiting time show the highest value on Process 6th which it six time per 20 production and the lowest being the 12th process which is one time. The decimal place in the number waiting does not count as waiting time was measured in whole single numbers.

4.3 Simulation Model Development

4.3.1 Manufacturing Flow Chart of Headboard Units Based on the Stations.

From the previous model, the time cycle is measured from twelve steps in producing the headboards. In this subtopic however, the simulation was then recreated using the same concept and method but distinguished by the stations of which the assembly of the headboard units is produced.

4.3.2 Process Chart Based on the Stations

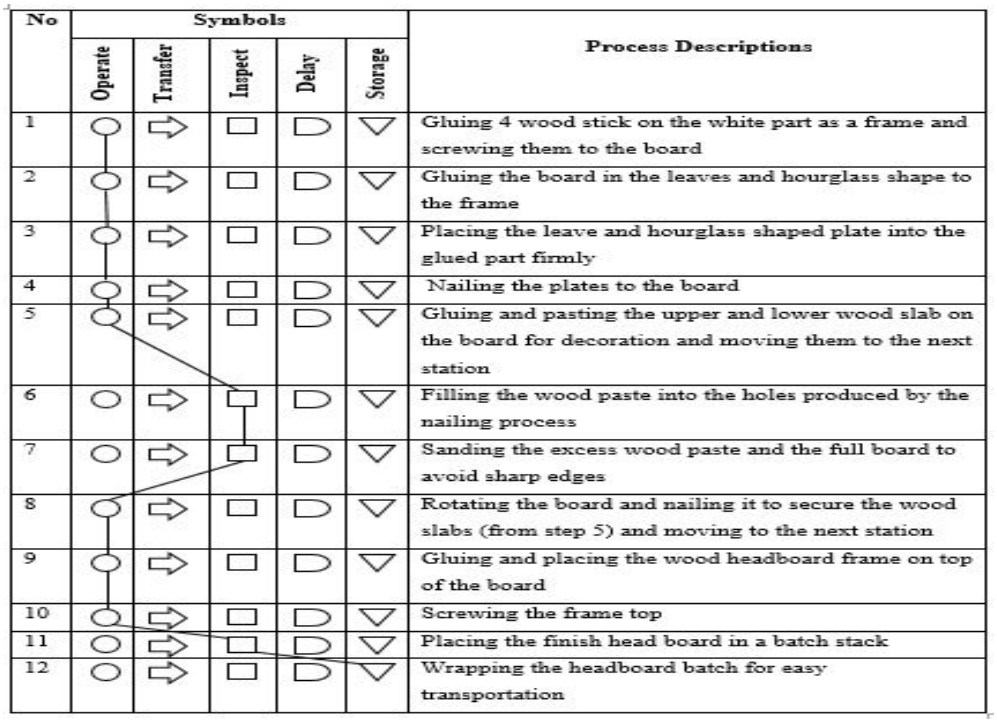

Figure 4.7 Process Chart for the Headboard Manufacturing Based on Stations

Figure 4.7 shows the process chart of the headboard assembly base on their station. The process consist of operation, inspect, transfer and storage. The delay column is still untouched as the data is based on observation and does not depict any ques in the assembly.

4.3.3 Time Cycle Observation of the Headboard Assembly Based on Stations

Table 4.2 Time Cycle of Headboard Manufacturing Based on Stations

No	Station Name	No of workers	1st Record (minutes)	2nd Record (minutes)	3rd Record (minutes)	Average (minutes)
1	A	2	2.97	2.87	2.92	2.92
2	B	2	6.07	6.05	6.07	6.06
3	C	2	4.55	4.58	4.60	4.58
4	D	2	2.71	2.67	2.81	2.73
5	E	2	1.48	1.53	1.55	1.52
Total Time (minutes)			**17.78**	**17.7**	**17.95**	**17.80**

Table 4.2 show the cycle time of a headboard assembly based on stations. The average time for the completion of the finished assembly process is at 17.8 minutes. Station B seems to have a longer time to finished than others stations and Station E seems to be the fastest.

4.3.4 Graph of the Cycle Time Based on the Processes

Figure 4.8 below shows a graph on cycle time against assembly stations in making of the headboard units. From the graph, Station B ranked to be the longest assembly time out of five stations. The shortest process shown on the graph happened at Station E

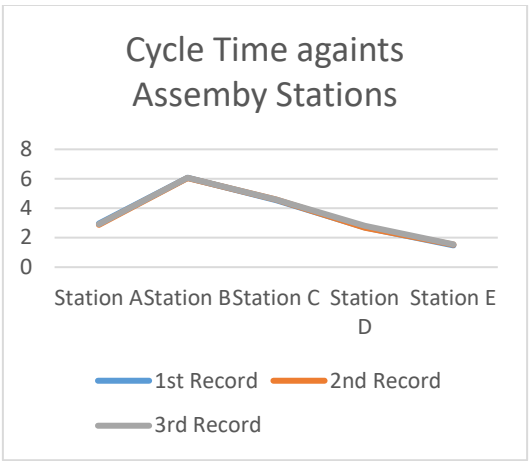

Figure 4.8 Graph on Cycle Time against Assembly Stations

4.3.3 Simulation Model Development Based on the Processes of Assembly.

Figure 4.9 shows the ARENA Simulation on headboard assembly based on the stations. In this simulation, the modules used is much simpler as it only consist of five process modules, five station modules and single create and dispose module respectively. The Create and Dispose module were critical element in any ARENA simulation as it depicts the starts and ending of the process or whatever the simulation you are trying to make.

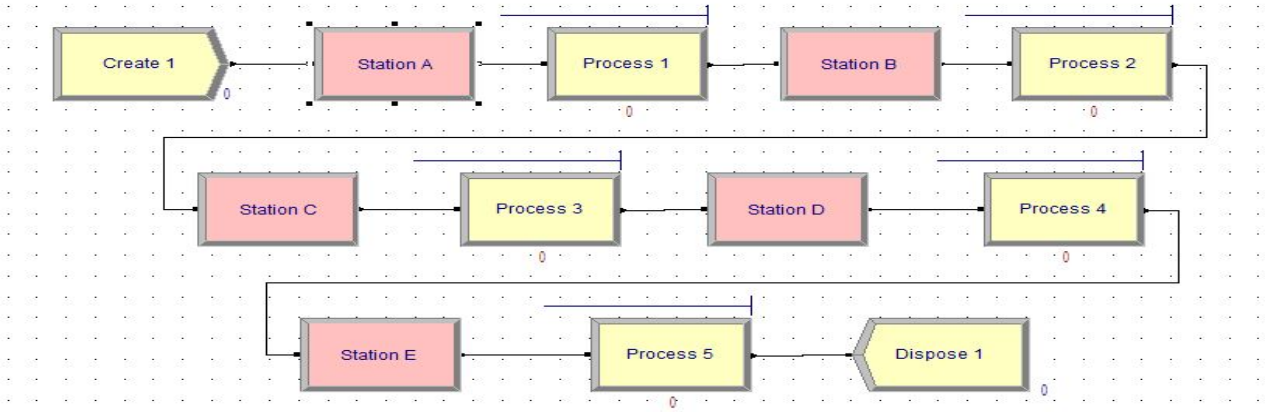

Figure 4.9 ARENA Simulation on Headboard Assembly Based on the Stations

From the result, we can conclude that the total average number of waiting time for the production of fifty headboard take so many time in process three as it added up to 224 minutes and the shortest waiting time for the headboard assembly is on process one at 87 minutes for the production of 50 headboards. The highest numbers of waiting time was on the third process which is 12 times and the lowest is on the first process which is 4 times.

Waiting Time	Average
Process 1.Queue	87.4752
Process 2.Queue	190.45
Process 3.Queue	224.62
Process 4.Queue	175.16
Process 5.Queue	107.96

Number Waiting	Average
Process 1.Queue	4.9119
Process 2.Queue	10.6939
Process 3.Queue	12.6128
Process 4.Queue	9.8355
Process 5.Queue	6.0619

Figure 4.10 Queue and Number Waiting Report by ARENA Simulation Based on Stations

5. Conclusion and Recommendation

5.1 Recommendations

For the recommendation, the study suggest to add workers on the places where the cycle time of the process is much longer than other. Now, some might argue that the addition of the workers may increase the cost of production, but in this case the study is to create a much efficient cycle time in order to keep up with the manufacturing demand.

Table 5.1 Alternative Time Cycle of Headboard Manufacturing Based on Stations with Added Worker

No	No of workers	Station Name	Average (min)	No of Workers (New)	Average (min)
1	2	A	2.92	2	2.92
2	2	B	6.06	4	3.03
3	2	C	4.58	3	3.05
4	2	D	2.73	2	2.73
5	2	E	1.52	1	3.04
Total Time (Min)			17.81	12	14.77

Based on Table 5.1 the amount of time of which the headboard is made still at 17.81 minutes but the number of worker has been increased from ten to twelve persons.

Waiting Time	Average
Process 1.Queue	1.1846
Process 2.Queue	2.0607
Process 3.Queue	2.3613
Process 4.Queue	2.3143
Process 5.Queue	2.0174

Number Waiting	Average
Process 1.Queue	4.8122
Process 2.Queue	8.3711
Process 3.Queue	9.5925
Process 4.Queue	9.4014
Process 5.Queue	8.1952

Figure 4.11 Alternative Queue and Number Waiting Report by ARENA Simulation Based on Stations

From the result, we can conclude that the highest total average number of waiting time for the production of fifty headboard take so many time in process three as it added up to 2 minutes and the shortest waiting time for the headboard assembly is on process one at 1 minutes for the production of 50 headboards. The highest numbers of waiting time was on the third process which is 9 times and the lowest is on the first process which is 4 times.

5.2 Conclusion

As the conclusion this study was a study on the cycle time of an assembly workstation using application of ARENA simulation software in a furniture industry. From the study, we can conclude that the Cycle time in manufacturing a headboard unit in AX Furniture is 17.81 minutes from starts to finish and the way to increase the time cycle efficiency is by altering the production line, in this case by adding workers on the critical long part of the process or stations.

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Biography

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