EasyChair Preprint

№ 4652

Modeling, Increasing Efficiency and Production Capacity in Melamine Dish Production Line

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February 1, 2021

MODELING, INCREASING EFFICIENCY AND PRODUCTION CAPACITY IN MELAMINE DISH PRODUCTION LINE.

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ABSTRACT

This research aims to study the working process of the Melamine dish production to increase the quantity of products and the quality of the working process. The experiment initially started by decreasing the employees in the production department, and then developed the new working plan leading to an effective working flow. The data was collected by counting the time of each production process. And then, the data was analyzed to find the problems and solutions in line balancing and production process by Flexsim software. The researchers proposed three alternatives: the first option was selecting a foil that has good properties, the second option was adding an oven to deduct the waiting time and to increase yield, and the third option was adding machines for extrusion. The simulation model was created to investigate the possibilities of the solution (3 hypothesis): it was analyzed by Flexsim. The result revealed that the first alternative is the most suitable since the number of the products is higher than other alternatives without adding equipment and machines. In the second option, the number of production capacity is hardly increasing. Although the third alternative can increase the production capacity effectively, but it requires a huge investment.

Keywords: *Increasing Efficiency*, *Flexsim*, *Improvement*

1. INTRODUCTION

Nowadays, melamine dinnerware is very popular because of its ease of use, beautiful patterns, variety of styles, and trendy. Therefore, it is in demand of the market and the price is suitable for the quality. The melamine ware manufacturing plant has to increase the production rate to get a bigger number of the products responding to customer needs.

The researchers are interested in improving the production process that can achieve greater efficiency and productivity. The main focus includes work-study (method study/work measurement): developing techniques and time study. The observed data was analyzed for building the alternative solution which can enhance the operation process. The method covers line balancing and simulation model: FlexSim was applied to evaluate the production capacity, production cost reduction, and process improvement in manufactories (simple workflow, convenience, rapidity of work, efficiency in production capacity).

2. THEORIES AND RELATED STUDIES

There are various theories and related researches used in this study to investigate the effective way of increasing productivity and improving the efficiency of production processes. The related theories consist of method study, production line balancing, waste reduction with ECRS, and simulation. The application of industrial engineering techniques (in the scopes of work-study, using ECRS to analyze the data, and building simulation model) has been used as a tool to investigate the possible solutions of the problems that occurred.

V.V Sokolova, OM Zamyatina (2017) created the simulation and developed supercluster modeling concerning the distribution of work in computer clusters. Cluster modeling assisted to find a suitable resource distribution of each task among different groups. The simulation was also developed (different intensity) for the beginning parts of the system. The result showed that job sequencing was analyzed promoting an optimal performance of the cluster computing.

Muthanna Jamil1, Noraini Mohd Razali (2016) created the simulation of line balancing in auto parts industries. Some companies have faced some issues such as it is impossible to change/control the quality of the product and the working process based on the customer requirement. Therefore, they explored the guidelines for increasing the positive effect by building the simulation which is a part of the line balancing process. It showed that production line balance positively impacts on Malaysian automobile companies.

Ting Yang, Dinghua Zhang, Bing Chen, Shan Li (2008) had researched plant layout and production lines that use a digital simulation of the factory environment. They aimed to analyze and optimize process production. A digital inspection platform can improve the reliability of the production process and production planning. Therefore, digital technology can promote factory productivity and increasing the quantity of products.

Ashkan Hafezalkotob, Hamid Ketabian, and Hesam Rahimi (2014) determined the problem of line imbalance in the Sadid pipe manufacturing sector using a statistical sampling technique and simulation model. The objectives were to solve the problem during the

production phase and to improve the position in the work station. It showed that the simulation was based on statistical techniques. Moreover, this is an effective method of balancing the complexity of production lines in real-world cases.

Muhammed Selman Eryilmaz, Ali Osman Kusakci, Haris Gavranovic, Fehim Findik (2011) analyzed the production process of the shoe factory by simulating the manufacturing process. It was aimed to analyze the daily production rate, the maximum possible output, and time flow. The finding indicated that the proposed simulation can increase the daily production capacity and it can reduce the production cost. Moreover, workload and waiting times were reduced as well.

2.1 Compressing Molding

The compression molding process is commonly used for thermosetting plastics (i.e. melamine) and it is used to produce the simple parts. The procedures include placing materials into the mold, close the mold using high pressure with heating, and then the plastic is going to melt and spread along the mold gap. When the plastic hardens, the workpiece is taken out from the mold. From this process, there are some disadvantages such as a lower number of products and time-consuming.

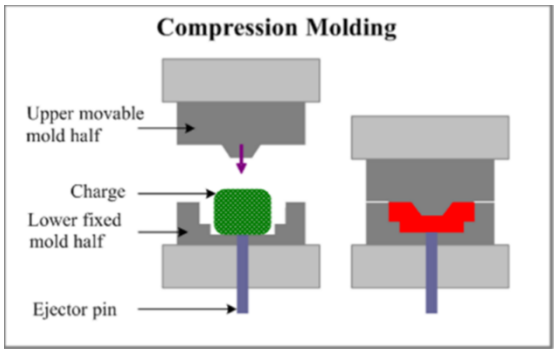

Figure 1 Compression Molding Process

2.2 10 Rules for working safely around machines

1. Do not use machines without skilled staff or training sessions.
2. Use the machine carefully. Please follow the guidelines or the given instructions.
3. Don't remove the safety tool or the protective shield from machinery
4. Please wear protective equipment which is suitable for the different kinds of jobs.
5. Stay clear of sharp or moving parts.
6. While the machine is running, do not adjust the cleaning or try to pull the stuck workpiece without stopping the machine first.
7. Wear tight-fitting clothing without jewelry that can be pinched or pulled by machines.
8. While checking, fixing, or repairing machinery, please hang up warning signs and use proper logout/Tagout.
9. Checking the machine conditions before working every time.
10. If you find the damaged or missing machine safety tools or protective shields, please immediately notify the supervisor.

2.3 3E's in enhancing safety in industrial factories

1. Engineering is the use of academic knowledge in engineering for calculating and designing machines and tools with the safest operating conditions. It also provides protection system installation, factory layout, electrical system, lighting, sound system, and ventilation, etc.
2. Education is aimed to provide education, training, and guidance to the staff, supervisors as well as those involved in the work session. It is to ensure that they should have sufficient knowledge and understanding of accident prevention. It can also enhance safety in the factory.
3. Enforcement is aimed to regulate rules and measures for work safety. It is a practice that must be declared to all of the workers. if anyone violates or fails to comply will be punished. Therefore. It can lead to achievement and it can increase the failure.

Benefits of Safety Regulations

1. Increased productivity: it links with the feeling of the staff or workers in the workplace, when they realize that their workplace is safe. So, they don't have to worry about their safety. A low level of fear or anxiety for insecurity leads to confidence, fast speed working, and efficiency.
2. Cost reduction: if the number of accidents or production losses is cut down, it means the companies can save the budget for those issues. So, Production costs would decrease accordingly.
3. To increase profit: if the working safety is increasing continuously, the production capacity is higher and the cost is reduced. This means the opportunity to generate more profits for the factories than ever before.
4. Motivating factor: it is contributed by the safety trust and less anxiety. This means the need to continue working in the workplace rather than moving to other places.
5. Maintaining the strength of human resource management: accidents during the working process and loss of property or life also impact the management of human resources. Therefore, creating a safe working image is important to represent the company's reliability.

3. METHODOLOGYAN

The experimental process began with the study of the production process of melamine plates from a real establishment. Data collection included time study and problems in the production process: then the data was analyzed to solve the problem found. The data was then used to create a simulation model using the FlexSim program. The results were analyzed and the best possible solution was determined. The operating procedure can be represented as follows.

1. Exploring the production process of Melamine ware
2. Collecting the data and problems
3. Identifying problems and then investigating the causes of those problems
4. Creating Simulation model by FlexSim
5. Analyzing the results
6. Concluding

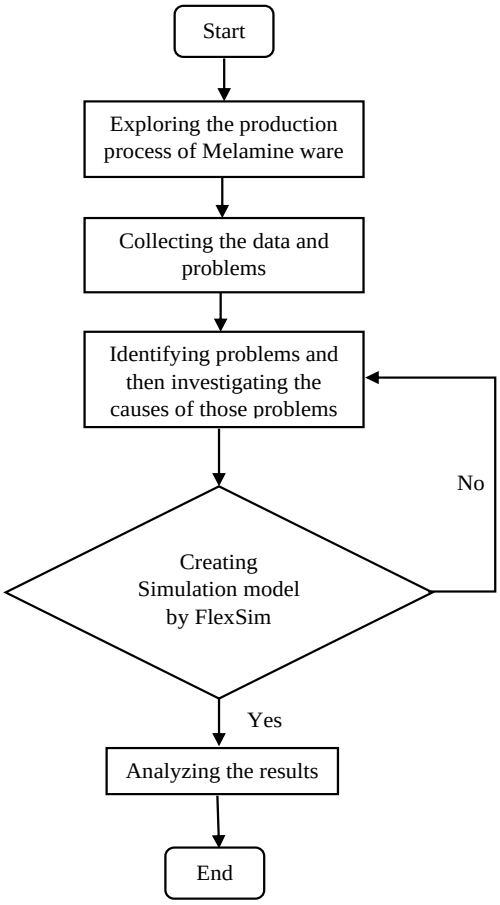

Figure 2 Operation map

3.1 Production process information

This experiment was studied specifically on melamine ware production line embellished with an intricate pattern. The process refers to the beginning step until the decorating step which is mentioned as follows:

1. Process of weighing melamine powder
2. Process of baking Melamine powder
3. Compressing Molding
4. Process of foil lamination
5. Process of vanishing
6. Process of scraping and checking

Note: Process 3, 4, and 5 used the same machine

3.2 Hypothesis

• To study the production process of the factory.
• To explore the methods to increase productivity using the FlexSim (simulation modeling software)

3.3 Input

Table 1 Shows the time of the first to fifth production process

Production process	**Time (minute)**				
	1	2	3	4	5
1. Process of weighing melamine powder	0.81	0.28	0.29	0.23	0.25
2. Process of baking Melamine powder	3.18	2.53	2.32	3.61	3.25
3. Compressing Molding	1.15	1.19	1.20	1.27	1.21
4. Process of foil lamination	0.55	0.54	0.58	0.59	0.59
5. Process of vanishing	1.12	1.12	1.15	1.21	1.20
6. Process of scraping and checking	0.85	0.64	0.87	0.74	0.80

Table 2 Show the time of the sixth to tenth production process

Production process	**Time (minute)**				
	6	7	8	9	10
1. Process of weighing melamine powder	0.30	0.26	0.19	0.24	0.19
2. Process of baking Melamine powder	3.18	2.72	2.57	2.71	2.46
3. Compressing Molding	1.17	1.15	1.14	1.20	1.19
4. Process of foil lamination	0.55	1.02	1.03	1.00	0.54
5. Process of vanishing	1.18	1.17	1.11	1.17	1.15
6. Process of scraping and checking	0.84	0.76	0.91	0.76	0.85

3.4 Testing process of model simulation

The researchers had defined 3 options to represent the virtual work system as shown in Figure 3, Figure 4, Figure 5, and Figure 6. The process consisted of one

employee, a weighing tool for melamine powder, a storage basket, melamine powder box, machinery for baking melamine powder, and machinery used for extrusion of melamine plates.

Figure 3 Pre-developed Simulation model

Option 1: Using good quality foil and time reducing in foil laminating process. This resulted in increased production capacity and enables a coating time of 30-35 seconds instead of 50-60 seconds.

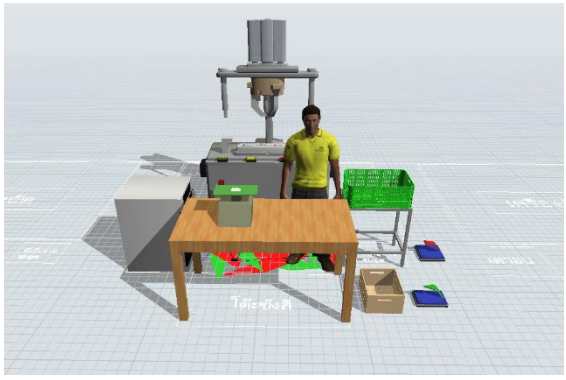

Figure 4 Simulation model for option 1

Option 2: Adding a drying oven. It can reduce the waiting time of the compressing molding and the workers can work continually.

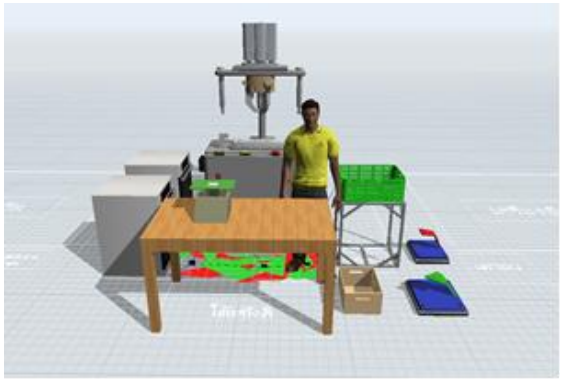

Figure 5 Simulation model for option 2

Option 3: adding 1 machine to the forming process and 1 oven to increase production capacity. This can reduce the waiting time in the production process and reduce the free time of workers**.**

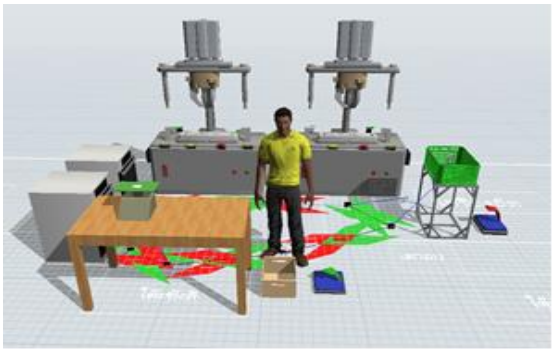

Figure 6 Simulation model for option 3

4. RESULTS

From the experiment, 4 simulation models were created including the pre-improvement model and simulation model for options 1-3. The production capacity of each option was collected by running the program for a total of 20 cycles in all models. The total production capacity of all simulation models is shown as follows.

Table 3 Shows the total number of production capacity.

Time	Production capacity (piece)			
	Pre-developed	Option 1	Option 2	Option 3
1	163	167	165	322
2	163	166	165	319
3	164	166	165	318
4	163	167	164	320
5	164	164	163	321
6	162	166	162	321
7	165	167	165	322
8	164	166	161	324
9	165	165	163	320
10	164	166	163	323
Total	1,637	1,660	1,636	3,210

The information is shown only 10 times because of the limitation of written space.

It can be seen that the modifications have a total capacity of 1,637 pieces, alternative 1, 2, and 3 have capacities of 1,660, 1,636, and 3,210 pieces respectively. Comparing the capacity of the pre-upgrade model and the alternative models, it was evident that option 1 had 23 pieces higher than the pre-upgrade model. Option 2 had only 1 piece higher than the pre-upgrade model. Option 3 had 1,573 pieces higher than the pre-upgrade model. Moreover, the production capacity of option 3 is doubly higher than option 1, 2.

Unfortunately, the third option has to add one machine and one oven, which increases the cost considerably. Therefore, option 1 is the best choice since it is the least costly alternative. This can reduce the time spent on the foil coating as well. If the foil coating is finished faster, the finished melamine powder can be brought into the further process as well.

5. CONCLUSIONS

As a result of the improvement of the melamine ware production line using a simulation model for each alternative, it was found that improvement of option 1 was the most productive choice based on the resulting cost of 1,660 pieces per day or a 1.3855% increasing in productivity. Hence, it can be concluded that that option 1 is the best choice which is enabled with the real situation.

ACKNOWLEDGMENT

We would like to express our sincere gratitude to Dr. Nara Samattapapong, instructor for the course "Simulation Systems and Applications 533343" for the continuous support for his patience, motivation, enthusiasm, and immense knowledge. Moreover, we would like to express the deepest gratitude to Srithai Superware Factory for the permission and cooperation to study the temperature and humidity control for mushrooms. We also would like to thank the School of Industrial Engineering and all of the related people who helped and gave some useful advice about this project.

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PHOTOS AND INFORMATION

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