DESIGN AND IMPLEMENTATION OF SEMI AUTOMATIC SYSTEM BATIK PRINTING TO ENHANCE PRODUCTION OF SMALL AND MEDIUM ENTERPRISES (SMEs) BATIK

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ABSTRACT

Mostly of the SMEs batik make batik pattern by using simple screen printing equipment manually that only can fulfill for small order. If the order is bigger, the SMEs batik will consume a lot of time to finish the order and the production quality will be not optimal. To overcome this situation, usually the SMEs batik will give this job to other printing company. This condition makes the profit of SMEs batik to be minimal. Some paper has recommended that automation system can enhance the production of products. Based on this problem, the objective of this research is to design and implement of semi automatic system batik printing to enhance the capacity of production in the SMEs batik. The method in this study is based on development research with the stages of design and implementation. The stages of design and implementation are based on real condition in SMEs batik for printing and drying batik printing. On part drying of batik printing system, the results of the experimental shows the optimal results as required by the SMEs. The temperature is setup at 50 Celsius, the speed of the motor of dryer is at 18 meters per minute and LPG consumption is at 0.25 kg per process. As a result, this equipment can be used to support SMEs batik in supporting productivity the creative industries batik in order to compete in era globalization.

Keywords: semi automatic, printing system, modeling, productivity, SMEs.

INTRODUCTION

The era of globalization has integrated all the power of the world economy into a system that no longer knows any bounds. The linkage between one field to other field such as manufacturing, trading and finance has intensively increased rapidly from time to time. As a result, it is needed a development policy to encourage small and medium enterprises (SMEs) into real power that can enhance local economic growth and the opportunity employment.

Batik is hand-painted using wax applied to the cloth. Then, the cloth that has been painted is used as clothing. Batik Indonesia has been identic with the nation as a cultural heritage and historic heritage for the nation Indonesia. On October 2, 2009, UNESCO designated Indonesian batik as a Masterpiece of Oral and Intangible Heritage of Humanity. As part of the acknowledgment, UNESCO insisted that Indonesia preserve their heritage [1]. This acknowledgement, cause the batik demand is increase significantly. In indonesia, batik become SMEs creative industry.

Batik can be produced by three methods. The first method is batik tulis (written batik) that can be produced by using a manual wax-resist dyeing technique. The batik painters can directly paint batik pattern to cloths. This process is very traditional and takes time so long. As a result, the price of batik tulis is the highest than next methods. The second method is batik cap (printed batik) that can be produced by using a copper blocks as mold to print the batik pattern. These method still uses a manually to stamp the cloths. The process of stamp to the cloths can be done faster than the first method. The last method is batik cetak (batik printing) that can be produced by using screen printing to print batik pattern.

Mostly SMEs batik in Indonesia use batik printing manually to print the batik pattern to cloths. This method is suitable for mass production and only need a little time to produce the batik pattern on the cloths in order to fulfill the order. Meanwhile, those conditions are impossible done by using method of printed batik or written batik. Because of the cheaper for mass production, usually batik printing is used for uniform of corporate employees, students and civil servants. Therefore the demand for batik printing always in mass product.

Up to now, most of the SMEs batik make batik pattern by using a simple screen printing equipment manually that only can fulfill for small order. If the order is bigger, the SMEs batik will consume a lot of time to finish the order and the production quality will be not optimal. To overcome this situation, usually the SMEs batik will give this job to other printing company. This condition makes the profit of SMEs batik to be minimal.

Some paper have recommended that designing is a crucial stage before to build a machine or system in real world system. Babagana *et al.*, [2] have recommended that design and construction are very important before to build a dryer for food preservation. By making design and construction, we can calculate the needs of local material that can be reduce the cost to build a dryer for food preservation. Simulation of a model can be used as tool to design a machine or system which has many parameters. By designing, optimal level can be reached. Corriere *et al.*, [3] and Mamun *et al.*, [4] stated that designing a fully automated microcontroller-based data logging system by labview (computer simulation) can make it to become

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simple, user friendly and inexpensive. Based on that, the objective of this research is to design and implement of semi automatic system batik printing to enhance the capacity of production in the SMEs batik.

MATERIAL

Control system

Generally, a control system consists of a specified input to subsystems and processes assembled for the purpose of obtaining a desired output with desired performance. Figure-1 shows a simplified a control system where input or desired response gives stimulus to control system to achieve actual response or output.

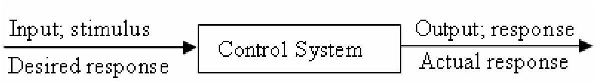

Figure-1. Simplified description of a control system.

The performance of the system can be seen from the actual response. Nise [5] gives example of the performance of the elevator to understand about two major measures of performance are apparent: (1) the transient response and (2) the steady-state error. In this example, passenger comfort and passenger patience are dependent upon the transient response. If this response is too fast, passenger comfort is sacrificed; if too slow, passenger patience is sacrificed. The steady-state error is another important performance specification since passenger safety and convenience would be sacrificed if the elevator did not properly level.

Performance test

Performance test is needed to be tested in order to give the best result for the system. There are some variations of parameters to be tested. The best variation result is used for the system. Diaz *et al*., [6] has studied the variation of properties like the peak cylinder pressure, peak cylinder temperature at various crank angles, at different relative air fuel mixture inlet temperatures and with hemi spherical combustion chamber and toroidal bowl to found that heated inlet air fuel mixture enhance combustion, peak cylinder pressure, peak cylinder temperature and change peak pressure timing. Ahmed *et al*., [7] tested blending the lemongrass oil with diesel in different proportions and testing the performance of blended diesel. The tests were carried out for combination of raw lemongrass oil with diesel. The performances were studied and it gives better fuel consumption and also improves emission norms. Another study that use performance test is Sarala *et al*., [8] that test biodesel in a single cylinder 4 stroke diesel engine to evaluate the performance characteristics.

METHOD

The method in this research is based on experimental investigation to analyze the semi-automatic system batik printing. Experimental investigation has been conducted by [9, 10] for their research. By using experimental study, they can find the best result from combination testing of their research. By combining the parameter, we can learn the characteristic of the system. This research development studies with the stages of design and implementation. The stage of design and implementation is based on real condition in SMEs batik for printing and drying batik printing.

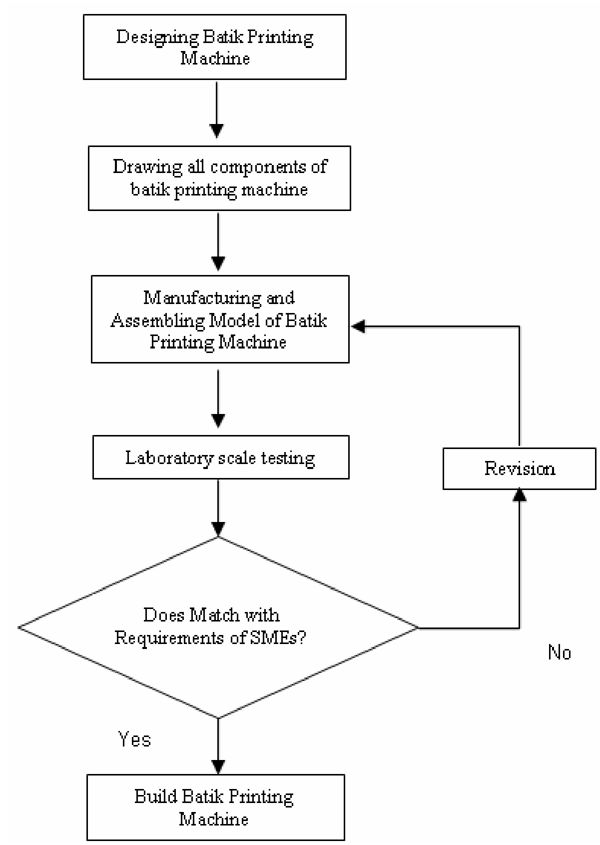

Figure-2. Stages of build batik printing system.

The stages of research to design Semi Automatic System Batik Printing consists of:

a) **Designing semi automatic system batik printing**
The design of semi automatic system batik printing is made to approach manual form of batik printing system. It is intended for workers in SMEs batik that still can not fully understand and familiar if the system is made full automatically. Therefore, the design of the system of batik printing is made in the stage of semi-automatic. In the printing section the design is made in order that can be done by only one labor. Another change can be made from manual to semi automatic is in the drying section. The dryer is automatically moving after the printing process of batik to cloths.

b) **Drawing all components of semi automatic system batik printing**

Describing the overall engine components to get the total information needs and precision components required

c) **Manufacturing and assembling model of semi automatic system batik printing**
Building a model of semi automatic system batik printing to realize the design.

d) **Laboratory scale testing**
Laboratory scale testing is to determine the workings and performance of the system. Does the system pass in accordance with the requirements desired by batik SMEs? The SME's requirements are: in the printing section can be done by only one person with the same quality as manual. In the dryer section, cloths batik printing results can move automatically with sufficient speed so that the cloths according to the level of dryness desired.

e) **Build semi automatic system printing batik**
If all the requirements of SMEs batik are met then the system can be made. Figure-3 shows design of semi automatic system batik printing.

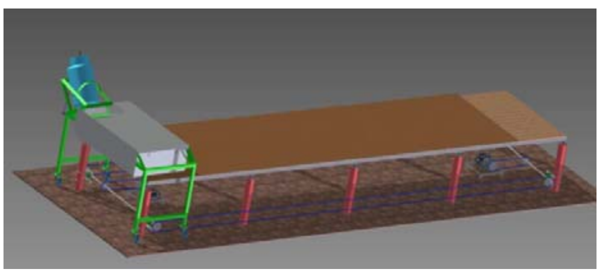

Figure-3. Design of semi automatic system batik printing.

RESULTS

A. Screen printing section

Firstly, the result of the research is to change the design on screen printing section. Initially, SMEs using traditional screen printing as shown in Figure-4. The traditional process of screen printing is done by two people to print batik pattern to the cloths. The workers are employed interchangeably to flatten the paint on screen printing. After that, they shift the printing screen to a position where the batik pattern will be printed again and positioned to the right position. This work is repeated until the entire cloth along the 24 meters is printed by batik pattern.

Figure-4. Manual process of screen printing in SMEs.

Development of research has resulted the design of screen printing section as shown in Figures 5 to 8. Figure-5 is a screen printing mold that fit the dimensions of the traditional screen printing is 2830 mm x 1580 mm. the screen printing mold is made from pipe box size 50x50 mm. Figure-6 shows wiper that is used to flatten the paint to the top of the cloths through screen printing.

The wiper can move up and down and also give pressure evenly on the surface of each screen printing.

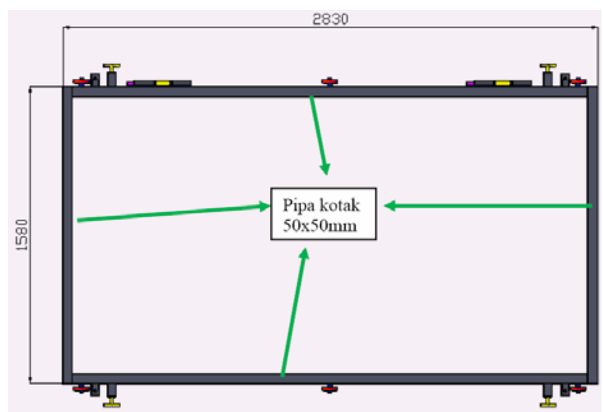

Figure-5. The pipe box of screen printing.

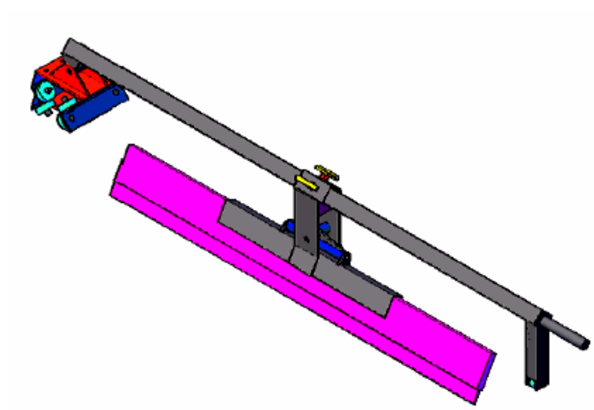

Figure-6. The wiper of screen printing.

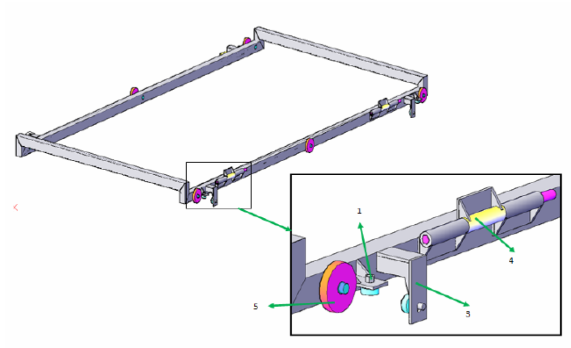

Figure-7. Frame for mold screen printing.

Figure-7 is a frame for supporting the mold screen printing that has been modified so that the box can be attached on top of the wiper. In screen printing mold consists of (1) to tie the wiper nut, (2) angle iron to hold the mold screen printing in order to remain flat, (3) the hinge point of attachment of the wiper box and (4) wheel which serves to shift the screen printing boxes.

Figure-8 shows a complete picture of the box screen printing. The advantages of this box screen printing: it can be done only by one person, and more efficient without having to lift a box screen printing but enough to shift according to the desired position.

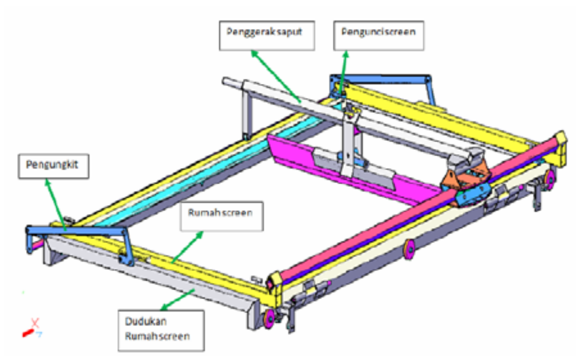

Figure-8. Complete picture of the box screen printing.

B. Dryer section

In the dryer section, there is an ECU (Electronic Control Unit) which serves to control the temperature of ± 50 degrees Celsius. Value of ± 50 degrees Celsius is obtained at the time of the observations in the field. Traditionally, the drying system is done at temperature ± 50 degrees Celsius with a tolerance at 5 degrees Celsius. ECU block diagram is shown in Figure-9, which consists of a set point, the ECU, Heat Exchanger, Dryer Box and Heat Sensor.

Set point is determined at a temperature of ± 50 degrees Celsius which becomes the input for the ECU. ECU is an electronic circuit. The input of ECU comes from a set point. Then the ECU orders the dryer to start a fire that uses LPG fuel. The size of the fire is set by the solenoid valve. If the temperature reaches 55 degrees Celsius, then the solenoid will work to shut off the flow of gas to the burner so that the flame will be extinguished. Whereas if the temperature drops to 45 degrees Celsius, then the solenoid will work to open up the flow of gas to the burner so that the flame large back lit. It works continuously until the drying process is complete.

Drying temperature can be continuously and maintained as desired (± 50°C), because the dryer is equipped termocouple associated with heat sensors that are placed close to the stove. Termocouple operates by pressing the button on the temperature control at ECU until reach the value of 50 as seen on Figure-10. Figure-11 shows the box dryer is used for Semi Automatic System Batik Printing.

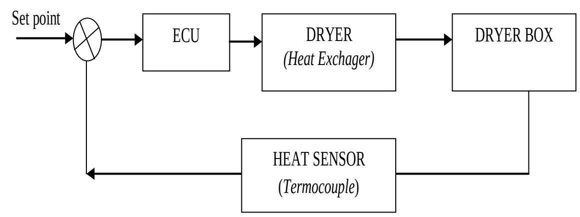

Figure-9. Block diagram of dryer section.

Figure-10. Electronic control unit for semi automatic system batik printing.

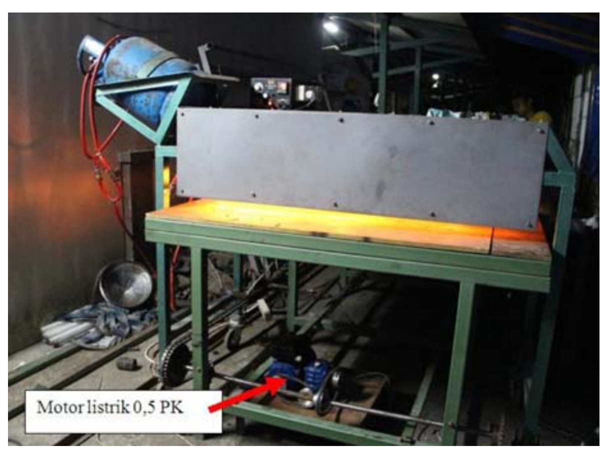

Figure-11. The dryer box of semi automatic system batik printing.

C. Experiments

Experiment is carried out by using 24 meters along the boards in accordance with the standards of SMEs. This standard is corresponding with to the length of cloths to be printed batik pattern on it. In conventional system batik printing, the dryer box is driven by human operator at a pace that is not constant. In one process (24 meters), the consumption of LPG is at 0.40 kg/process with the uncontrolled temperatures. By increasing the distance, the temperature in dryer box is also increasing. The setting of flames is carried out manually on the basis of the experiences and feelings of the operator. Interviews and observations results show that batik patterns on cloths is called dry and stick, if the temperature in cloths is at ± 50 degrees Celsius with a tolerance of 5 degrees Celsius.

Table-1. The manual process without temperature control.

Length of table (meter)	**Time** (second)	**Temperature** (C)
1	5	33
2	10	35
3	15	42
4	20	46
5	25	48
6	30	49
7	35	49
8	40	49
9	45	51
10	50	53
11	55	54
12	60	56
13	65	57
14	70	58
15	75	60
16	80	61
17	85	62
18	90	64
19	95	65
20	100	66
21	105	68
22	110	69
23	115	70
24	120	72

Table-2. The parameter results of experiment 1st.

Length of table (meter)	**Time** (second)	**Temperature** (C)
1	3,3	37
2	6,6	40
3	9,9	47
4	13,2	48
5	16,5	49
6	19,8	50
7	23,1	52
8	26,4	53
9	29,7	55
10	33,0	55
11	36,3	55
12	39,6	54
13	42,9	54
14	46,2	53
15	49,5	52
16	52,8	52
17	56,1	51
18	59,4	50
19	62,7	50
20	66,0	49
21	69,3	49
22	72,6	48
23	75,9	47
24	79,2	46

Experiments were carried out by adjusting the movements of dryer box with the three-speed are: 18 m / min, 20 m / min and 24 m / min. This experiment uses a motor with a power of 0.5 OD. The first experiment using the following parameters: the speed of dryer box is at 18 m/min or 0.3m/s, LPG consumption is at 0.2 kg/process and controlled temperature at ± 50 degrees Celsius. The results can be seen in Table-2. From Table-2, we can know that at a distance of 3 meters until 24 meters, drought level in batik patterns on cloths can be considered dry. This is in accordance with the requirements of SMEs with a temperature tolerance of 5 degrees celsius from 50 degree celsius. At a distance of 9 meters, termocouple will give a signal to the ECU to extinguish the fire. Therefore, at a distance of 10 meters to 24 meters fire on dryer box die. This will be saving the use of LPG.

The second experiment using the following parameters: the speed of dryer box is at 20 m/min or 0.33 m/s, LPG consumption is at 0.18 kg/process and controlled temperature at ± 50 degrees Celsius. The results can be seen in Table-3. From Table-3, we can know that at

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a distance of 6 meters until 24 meters, drought level in batik patterns on cloths can be considered dry. This is in accordance with the requirements of SMEs with a temperature tolerance of 5 degrees celsius from 50 degree celsius. At a distance of 14 meters, termocouple will give a signal to the ECU to extinguish the fire. Therefore, at a distance of 15 meters to 24 meters fire on dryer box die.

Table-3. The parameter results of 2nd experiment.

Length of table (meter)	**Time** (second)	**Temperature** (C)
1	3,0	33
2	6,0	36
3	9,0	40
4	12,0	42
5	15,0	44
6	18,0	46
7	21,0	46
8	24,0	48
9	27,0	50
10	30,0	51
11	33,0	52
12	36,0	52
13	39,0	54
14	42,0	55
15	45,0	55
16	48,0	53
17	51,0	52
18	54,0	51
19	57,0	51
20	60,0	50
21	63,0	49
22	66,0	48
23	69,0	47
24	72,0	47

The third experiment using the following parameters: the speed of dryer box is at 24 m/min or 0.4 m/s, LPG consumption is at 0.15 kg/process and controlled temperature at ± 50 degrees Celsius. The results can be seen in Table-4. From Table-4, we can know that at a distance of 6 meters until 24 meters, drought level in batik patterns on cloths can be considered dry. This is in accordance with the requirements of SMEs with a temperature tolerance of 5 degrees celsius from 50 degree celsius. At a distance of 21 meters, termocouple will give a signal to the ECU to extinguish the fire. Therefore, at a distance of 22 meters to 24 meters fire on dryer box die.

Table-4. The parameter results of 3rd experiment.

Length of table (meter)	**Time** (second)	**Temperature** (C)
1	2,5	35
2	5,0	37
3	7,5	42
4	10,0	43
5	12,5	44
6	15,0	45
7	17,5	47
8	20,0	48
9	22,5	49
10	25,0	50
11	27,5	50
12	30,0	51
13	32,5	51
14	35,0	52
15	37,5	52
16	40,0	53
17	42,5	53
18	45,0	54
19	47,5	54
20	50,0	54
21	52,5	55
22	55,0	55
23	57,5	53
24	60,0	53

The results of the three experiments can be concluded that the first experiment with the parameter as follows: the speed of the dryer box is at 18 m/min or 0.3 m/s, with LPG gas consumption is at 0.2 kg/processes has advantages in efficiency of use of LPG as compared to the second experiment and the third experiment. It can be seen from Table-5, the length of time of turn on the flame of LPG only 3 meters or 9.9 seconds for a long time and the shutdown of LPG as far as 15 meters or as long as 49.5 seconds.

Table-5. The comparison of LPG consumption based on distance.

Number of experiment	**Distance for intolerance temperature** (meter)	**Distance for tolerable initial temperature** (meter)	**Distance for tolerable last temperature** (meter)	**Distance of turn on LPG** (meter)	**Distance of turn off LPG** (meter)
1	2	3	9	6	15
2	5	6	14	8	10
3	5	6	21	15	3

CONCLUSIONS

Design and implementation of semi-automated system batik printing can be used to support the performance and productivity of SMEs batik where conventional systems still use two people to print batik patterns on cloths. With the new design, batik printing can be driven and printed only by one person.

For the dryer box, the conventional system uses LPG at 0.4 kg/process and the processing time at 120 seconds while using this research, the needs of LPG only 0.2 kg/process with a process time at 79.2 seconds. In a subsequent study will be examined in more detail the experimental design and the use of heuristic optimization methods that will get more optimal results.

ACKNOWLEDGEMENTS

The Authors would like to thank to DP2M DIKTI (Indonesian Higher Education Directorate General) for its financial support under MP3EI year 2012-2013.

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