

Analyzing the Factors Influencing the Laminator Machine Operation and Strategies to Improve Its Productivity

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ABSTRACT

The paper consists the finding of the research done to increase the productivity of a Laminator Machine in a production plant of a well established organization located in Ja-Ela, which produces heat insulators from low density polyethylene by thermally expanded. This machine processes one of the most important production steps of the producing the laminated foam sheet. That is laminating foil to the foam sheet. In this paper first it will give brief introduction to the research. Then it will discuss the literature that supported this research. Next research methodology will be discussed. Then it will give how the necessary data was collected and how the analysis has been done from these collected data. This research will give the way of improving the productivity of laminator machine when laminating 3 mm Yellow foam sheet from MPF foil around 6.67 % per shift. Finally it will discuss what the factors that influencing the laminating process are and what the alternative solution(s) that can be taken in order to reduce or eliminate occurring of these factors are.

KEY WORDS: Laminator machine, Laminating 3 mm Yellow foam sheet, Process sequence, Time study.

INTRODUCTION

Managing a manufacturing firm in today's world is a tremendous challenge. Top managers of companies facing with an endless number of problems that arise from continuing inflation, fluctuating energy costs, high taxes & the government regulations, shortage of capital, workers, dissatisfaction and intense foreign competition. As a remedial measure, most firms begin to concern on improving productivity. While paying less attention on controlling input while enhancing output which directly link with the productivity, manufacturers concern much on factors such as working environment, effective raw material usage, managing human resources, and use modern techniques to improve productivity (Amrine, *et.al*, 2006).

The research focused on a manufacturing organization that produces products from Low Density Polyethylene (LDPE) by thermally expanding. They are the pioneer organization who produces such products in Sri Lanka. The company provides these products to the local as well as foreign market. The most demanding product of the organization is laminated foam sheet which is scientifically called "Thermally Reflective Foil". The product is used in industrial work and as well as in domestic works.

The laminated form sheet is produced through a machine called Laminator which bonds the foil to the foam sheet. During a normal 24-hour shift, around 120 to 140 rolls of foam sheet would be laminated. This performance level can be achieved when the machine continuously engages in laminating process throughout the 24-hour's shift and also when orders are exist. However the production records of the machine clearly indicates a significant difference in production performance between day and night shifts.

The effective and efficient operation of the machine determines the firm's ability to meet the demand of the product. The inefficient and ineffective performances of the machine results customer dissatisfaction and it are one of major causes for losing customers. Since there is only one machine available for the laminating process, it makes the situation which is crucial for the organization. Therefore frequent break downs and inefficient operations of laminator machine directly affect the production of laminated foam sheets, as a foam sheet cannot be produced without bonding the foil. And also there is no alternative machine or process to laminate the foil to the foam sheet. Therefore it is very important to maintain the machine in such a way that it will minimize a number of stoppages and utilizes the machine effective and efficient manner. Otherwise the organization will lose the market leadership. The organization's inability to meet required order quantity on time creates dissatisfaction among customers and it leads the organization to loss their important customers. Since the laminated foam sheet is one of the most popular and demanding products customer dissatisfaction will adversely affect the organization's overall business success

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LITERATURE

The productivity is one of the demanding issues in today's businesses irrespective of the size, legal position, private or government, service or manufacturing or any other base. Each and every business endeavors to improve the productivity. And also enhancing the productivity, in any means, is vital since it determines the economic progress of a country at large.

Productivity

Productivity simply measures the output resulting a given input. In other words productivity is a measure of effective use of resources. Usually it expressed as the ration of output to input (IMGT 4172-PT Lecture Note, 2008).

$$\text{Productivity} = \frac{\text{Out put}}{\text{In put}}$$

Factors affecting productivity

There are several factors that influence the productivity of a machine in a production plant, as those are human resource, working environment, management techniques, available technologies and managerial procedures. To interpret machine's productivity, the most common method used is carrying out work study. Under the work study there is a method called time study which is a method that is used in the research to interpret the productivity of the laminator machine. When considering the machines productivity, the supplying of raw materials on time and maintaining safety stocks to run the machines are very important. Therefore time study and inventory management are imperative to ensure the productivity.

Time study

Frederick W Taylor introduced the time study to the world as an essential part of the scientific management. He introduced time study while he was serving for the Midvale steel company in 1881 as a gang boss and foreman. The time study will help managers revise the production targets so that they are appropriate to the workers. Also it helps identify the sequence of activities that are performed by a worker in a production process, and opportunities to reduce the throughput time. Time study will also reveal when and where the delays occur in a production process, especially performed by workers. Also it helps standardize a sequence of activities that are performed in a process. Today's factory managers use time study as a tool to increase the overall efficiency of the plant making it is possible to pay higher wages to labour. Further it lowers the cost of the finished products and there by reduces the price to the customer (Amrine. *et. al*, 2006).

Steps of Using Stop Watch Techniques in Time Study

- Secure permission from the supervisor for making the study and explain to the operator the purpose of the observations
- Check the job method for improvements; standardize the job method and recording on the observation sheet complete information about the job and operator.
- Break job down into elements and record those elements in detail on the observation sheet
- Determine and record the times for each of the elements.
- Rate or level the operator's performance
- Provide allowances for personal time fatigue, machine delays etc.
- Calculate the standard or allowances.

The equations that are used in the time study are shown below. The International Labour Office has tabulated the effect of working conditions to arrive at an allowance factor for personal delays and fatigue. Using this table, an allowance factor for each element of study can be determined. For example, an element of a given study may involve application of a 40 pound force. Because of this force analyst-would use an allowance of 9% in structuring the allowance computation for the element. An additional reason for adding an allowance occurs when an operator is tending more than one machine must wait or be delayed while the operator complete work on another machine (Amrine. *et. al*, 2006).

$$\text{Standard time} = \text{Normal time} * \frac{100 + \text{allowance in percent}}{100}$$

Also some companies provide special allowances for machine controlled operation when a wage incentive plan applies. It is the job of the analyst to determine a suitable machine interference allowances to get a valid standard time. The standard or allow time is determined by increasing the normal time by the total amount of the allowance as above (Amrine. *at all*. 2006)

Inventory Management and Control

The ultimate objective of all manufacturing organizations is to realize a profit through the operation of the business. To achieve this, all most all organizations strive to improve their overall productivity in the firm. An effective inventory management system is necessary to achieve this objective. The objectives of the inventory management and control is to maintain optimum inventory levels and inventory turnover of the business at maximum profit and through the control of inventories to ensure that the right material in the right quantity and of the right quality, is made available at the right place at

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the right time This will reduce the delays that occur when not having enough raw material at the right place at the right time. An effective inventory control system will help smoothly functioning of the processors in an organization with minimum delays and minimum wastage (Amrine. *et.al*, 2006).

METHODOLOGY

This research design is based on research type of deductive reasoning. The primary data was used in the research. Time study was carried out to gather primary data and analyze the productivity of laminator machine. Also observation method was used to identify the factors that delay the laminating process. The data was gathered on single side lamination of 3 mm yellow foam sheet from MPF foil as the sample since it is the product most of the times laminate by the machine. The data analysis has been done using timing graphs and taking average time spent for laminating a one roll of 3 mm yellow foam sheet from MPF foil. The prioritize the identified factors that cause to delay the laminating process through surveying. Survey was done with the help of questionnaire, which was developed using Lickert scale and responses were analyzed by mean and standard deviation. By evaluating the alternative solution with respect to criteria, the best solutions were identified.

DATA COLLECTION AND ANALYZING

Time study has been carried out to collect the required primary data. After calculating the average time spent on each activity, the appropriate time allowance percentage, which should include as rest allowance, were decided according to the standard reference. Average standard time after allocating allowances for the routine activities are in the Table 01. The Table 02 illustrates the average time spend on non routine activities that are performed in laminating 3 mm yellow foam sheet from

MPF foil after allocating allowances time. After that the total average time spent on laminating 3 mm yellow foam sheet was obtained. Then the total average finishing time was obtained by adding these time periods. Non routine activities were excluded in this calculation since they cannot be reduced further. Then using a timing graph (Refer Figure 01) the researcher shows at what sequence these laminating process should be done in order to reduce the total finishing time when laminating 3 mm yellow foam sheet from MPF foil. The following details were obtained by mathematical analysis. They are

- Total average standard time for finishing a roll to be laminate in performing activities in actual sequence without considering replacing foil is 309.31 seconds
- Total average standard time for finishing a roll to be laminate in performing activities in propose method without considering replacing foil is 278.91 seconds
- Therefore time that can be save by following the propose sequence is 29.5 seconds per one roll of laminating 3 mm Yellow foam sheet.
- Maximum number of 3 mm yellow foam sheet (Single side lamination) that can be laminated in a 12 hour shift by performing the laminating process in actual sequence is 90 rolls
- Minimum number of 3 mm yellow foam sheet (Single side lamination) that can be laminated in a 12 hour shift by performing the laminating process in proposed sequence is 96 rolls
- The increase numbers of rolls that can be laminate by performing activities in propose sequence is 6 rolls
- The amount of productivity increased per shift is 6.67% per shift

During the observation of the laminating process, factors that delaying the process were identified. Those factors are illustrated in Table 03.

Production Description	Percentage allowances for routine activities												
	A	B	C	D	E	F	G	H	I	J	K	L	M
3mmYellow Foam Sheet (s/s) lamination	26.14	175.81	1.99	2.95	28.38	30.16	5.22	4.43	4.61	14.73	4.73	-	10.16

Table 01: Average Standard Time after Allocating Allowances for Routine Activities

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Production Description	Time taken for non routine activities (in Seconds)						
	N	O	P	Q	R	S	T
3mm Yellow foam sheet (s/s) lamination	28.84	185.46	48.50	4.08	30.60	41.60	47.11

Table 02: Average Standard Time after allocating Allowances for Non routine activities

Table 04 shows the gathered responses from the issued questionnaire with the respective priority numbers assign according to the scale that use.

Following Figure 01 will shows the actual sequence of activities that performed when laminating 3 mm yellow foam sheet and proposed sequence of activities that should be performed when laminating 3 mm Yellow foam sheet from MPF foil in order to reduce the total finishing time.

SOLUTION TO THOSE DELAYING FACTORS

The following shows the alternative solutions available to each factor and if more than one solution is available to a single factor, then the best solution among them was selected by analyzing each options using several criteria's. This is called best option in this section and mention in when there is more than one solution available.

Factor
(1) Rapid changes in production schedule.
(2) Non availability of foil (MPF or AL) in the stored place
(3) Non availability of foam sheet in the store place
(4) The required rolls are wet by rain
(5) Printer not working due to ink sticking in the printer head.
(6) Non availability of printer ink
(7) Non availability of silicon oil.
(8) Foam sheet sticking to the heater roll.

Table 03: Factors That Delaying the Laminating Process

Factor 01: Sticking the Foam Sheet to the Heater roller

Solution:

- (1) Use a tape called Netflon which is a foam adhesive tape.

Factor 02: Rapid Changes in Production Schedule

Solutions:

- (1) Maintain adequate stocks of finished goods in transit stores by increasing the space in stores.
- (2) Upgrade the forecasting system
- Best option – Implement both. This does not mean to implement simultaneously. This mean to get the full benefit from each option firm cannot implement a one solution and stop. They have to move to the other solution as well.

Factor 03&05: Non availability of Printer Ink and non availability of Silicon Oil in the Stock.

Solution:

- (1) Maintain an adequate safety stock of printer ink and silicon oil.

Factor 04: Printer Machine not working due to Ink sticking in the printer head.

Solutions:

- (1) Clean the printer head at a scheduled time period.
- (2) Teach the machine operators how to use printer machine to its standard.
- Best option – Implement solution 02

When considering the option 01 it will not stopping the cause that creating this problem. Also the liquid have to use to clean this ink is very expensive. Therefore regular cleaning means the cost of maintenance is increasing. Also this option involve some kind of risk that person who is doing this cleaning process as if this liquid is touch with the human skin then it will affect the human skin. When option 02 is considered this will stop this cause that creating this problem. Therefore the most suitable solution is option 01

Factor 06: Required Rolls are Wet by Rain

Solutions:

- (1) Remove the wetness by sweeping the rolls from a cotton piece of cloth by hand.

(2) Use the concrete slab over the tube plant to dry
Factor and assign priority number for each factor

Factor	Average marks	Assign priority no
(1) Rapid changes in production schedule.	2.00	2
(2) Non availability of foil(MPF or AL) in the stored place	4.17	8
(3) Non availability of foam sheet in the store place	3.83	7
(4) The required rolls are wet by rain	3.66	6
(5) Printer not working due to ink sticking in the printer head.	2.67	3
(6) Non availability of printer ink	3.50	5
(7) Non availability of silicon oil.	3.33	4
(8) Foam sheet sticking to the heater roll.	1.00	1

Table 04: Average marks that obtain for each factor

- ❖ Scale
- 1- Most frequently occur
- 2- Frequently occur
- 3- Neither frequently nor from time to time occur
- 4- From time to time occur.
- 5- Rarely occur

- (3) Use the factory roof to dry the wet rolls from the Sunlight.
- (4) Fixing of aluminum loovers to the upper part of the store wall to prevent rain water coming inside to the store
- Best option – Implement option 04.

When consider first three options it involve moving foam sheet rolls from one place to another place. This may cause to damage to the foam sheet. Once these foam sheets are damaged those cannot be used to further processing such as laminating or doubling. When considering option 02 & 03 the workers have to move these foam rolls through a stair case for a number of times. Hence occurring an injury to a worker is possible. Also when considering the option 01, when this sweeping process is done it takes considerable amount of time as well as during that period the machines (Rewinder or Doubling machines) cannot carry out its usual operation. When compared to all

the rolls which are wet by rain from sunlight. the available options implementing option 04 will required a considerable amount of initial capital. But this additional initial cost is offset by other criteria that are considered and it's a once and for all permanent solution and also completely eliminating the recurring expenses and time consumed in drying the wet foam rolls.

Factor 07: Non availability of Foam Sheet in the Stored Place & Factor 08: Non availability of Foil in the Stored Place

Solutions:

- (1) Use a card system to bring the required roll (foam or foil rolls) to stored place before foam sheets are exhausted.
- (2) Use an indicator system to bring required rolls (foam or foil rolls) to stored place before exhausting foam sheets
- (3) Use an walkie-talkie to communicate with the relevant person
- Best option – Implement option 01. Because it cost less than the other two options to implement. Also the maintaining cost is less and easy compared to the other two options. In option 01, the capacity of information that can be communicated is unrestricted as well as the occurrence of misunderstanding is rare compared to option 02.
- Option 03 have the shortest response time compared to the other options but may have to bind by legal requirements when using such a device. In option 02 if one of the indicator bulbs is not functioning due to a fault the meaning conveyed may totally different to the intended meaning. To avoid it, a constant checking of the system is necessary. For handling a communication system (walkie-talkie) need special skills as well as if a break down occurs the repairing cost would be high. Therefore the best option is to use a card system for both these factors (factor 07 and factor 08)

CONCLUSION

The productivity of the Laminator machine can be improved at least 6.67% per shift only by rearranging the sequence of performing laminating process activities when laminating 3 mm yellow foam sheets from MPF foil. The most important point is that, to increase the productivity around 6.67% per shift can be achieved by the organization without spending any additional cost. The proposed sequence that should be followed when laminating process is

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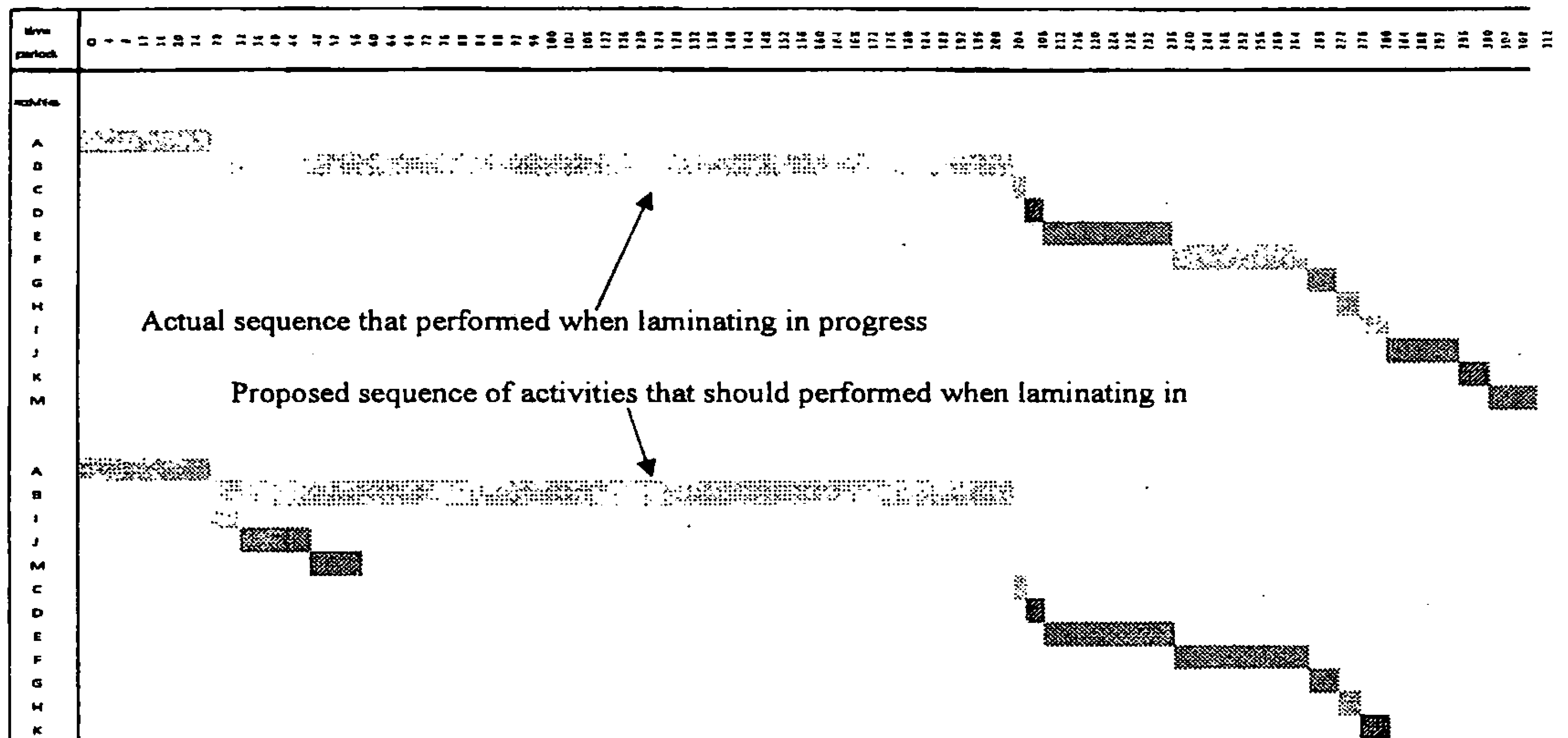


Figure 1; Timing graph of actual sequence and proposed sequence of laminating process

going and is not restricted to apply when laminating 3 mm yellow foam sheet from MPF foil. This proposed sequence can be applied the thickness range of laminating foam sheet (single side lamination only) from 2 mm to 20 m Beyond this range the proposed sequence cannot be applied due to necessity of some additional activities should be performed but have not been recognize by this research.

All the factors (eight factors) identified in this research are treated as factors affecting the laminating processes and will stop the laminating process once they have occurred. Therefore, implementing the solution to each and every factor is important. Hence only the production process of laminating process can be performed continuously with minimum stoppages. This means that the increase in the production rate of the laminator machine. In other words increase the productivity of the laminator machine. If the organization implement the suggested solutions or any other solution that eliminating the occurring these factors, the actual increase in the productivity will be much more higher than the figures given in the productivity improvement in this research as the research considered the time that spent on these delays to calculate the productivity improvement.

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