Success Factors of the Batch-Wise Process Flow Implementation in a Production Line: A Case Study of a Garment Manufacturing Company

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ABSTRACT

Apparel industry is one of the largest contributor to the export revenue of Sri Lanka. Sri Lankan apparel industry has earned a well reputed name for supplying reliable and quality garments at competitive prices. About 75% of direct and indirect employment opportunities have been provided to the locals through this industry. Even though the Sri Lankan apparel industry is in well-established and matured phase in its product life cycle, it faces some common issues like, high delivery lead time, high work in process (WIP) and higher rate of end-line rejection, etc. High delivery lead time is occurred mainly due to time delaying in raw material importation. End line rejections can be reduced if there is unit wise quality inspection at work stations. WIP could be reduced through a proper working layout and working conditions. This study was carried out with the aim of identifying the success factors of batch wise process flow implementation in a garment production line, by referring one of the leading apparel manufacturing company. WIP rate was taken as a measure to indicate the success of batch-wise process flow. If the WIP rate is less or zero at a given time in a particular work station, it indicates that the implemented process is successful.

Seven factors have been identified to measure the success of the batch-wise flow implementation in the production line. They are; machine down time, needle down time, number of machine operators available, number of end line rejection, line balancing, damage occurring in a garment and frequency of change over. Since the batch wise process flow was in the introductory stage at this factory, the study was employed only to a single production line out of 20 production lines. Data were collected during 30 working days for two working shifts. There were 28 work stations in the selected production line. The study adopted an observation method and data were collected through pre-designed observation sheets.

According to the analysis, machine down time, needle down time, number of machine operators available and end line rejections are directly affected to the success of batch wise process flow implementation in the production line.

KEYWORDS: Apparel Industry, Batch Wise Process Flow, Lean Manufacturing, Work in Progress

INTRODUCTION

Apparel industry is one of the most attractive industries when considering Sri Lankan exports. 44% of earnings from export are gained by the apparel industry (Central Bank Sri Lanka, 2014). With the economic growth of the country, operational cost of the business also increased. Sri Lanka has to compete with other low cost, high volume production countries like China, Vietnam and Bangladesh. Hence, Sri Lanka's competitive advantage has to be changed from low cost producer to differentiation. With such intention, most of the large organizations try to adopt lean manufacturing concept into their production floor. This study concerns the success factors of implementing batch-wise process

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flow in a production line in an apparel company. To improve the production process, batch-wise process flow, which is one of the tool of lean manufacturing implemented in the production line.

Problem Definition

One of the major issues that the apparel industry faces is failure to meet the due dates of the customers. Some of the reasons are less skilled workforce, high WIP and higher rate of end line rejection. Both less skilled work force as well as high end line rejection contribute to high WIP. Therefore, it is necessary to identify and remove the causes for WIP to reduce it and through that improve the productivity of the production line. Hence, the research problem can be formulated as how to reduce WIP, which is the measure of success of batch-wise process floor in the production lines.

Research Objectives

The objective of the study is to identify the factors affecting the success of the batch-wise process flow implementation in a production line.

Research Questions

The research question can be formulated as, 'what are the factors affecting to the success of the batch wise process flow implementation in a production line?'

LITERATURE REVIEW

Work in Progress (WIP)

WIP is defined as the material that has been entered in the production process, but is not yet a finished product. Therefore WIP refers to all materials and partly finished products that are at various stages of the production process. If any production process consist high rate of WIP, it indicates the inefficiencies of the production process. Lean manufacturing focuses on minimizing inventory for materials, WIP and finished goods. This study considers the reduction of excess inventory of WIP, which is a result of overproduction and waiting (Technopak, 2011).

Reasons for the higher WIP are time taken for maintenance activities at machine breakdowns, poor layout design which creates more bottleneck operations, higher rejection at the end of the line quality checking, defective garments, time between needle breakdown and restart the operation, frequent style changing and number of machine operators available at a line.

Lean Manufacturing

For a manufacturing process it needs the involvement of all the stake holders; employees at all levels, suppliers, and customers (Ohno, 1998). However it requires half of the resources, including human effort, tooling cost, engineering time, manufacturing space and half of the time to develop a new product as mass production (Liker, 1999). This results the pulling of material from downstream operations only when needed and inculcate team work culture, strong focus on serving customer with high quality and low cost products in short delivery times. The fundamental lean activity of eliminating waste requires analysis of the production process and the continuous identification and elimination of waste. This heavily relies upon each individual worker in identification and elimination of waste. Therefore, for the success of the lean implementation, active involvement of the workers is highly essential (Wickramasinghe, 2012).

Batch-wise Process Flow

Implementing batch wise process flow will be a good solution for high WIP in production line. Batch wise process means each machine operator is assigned specific number of pieces for a given time period. Since there is a constant number of pieces with each operators, bottleneck operations can be easily visualized. At the same time from each batch, one piece needs to check for quality by the machine operator. This will reduce the end-line rejection rate too.

From the above literature, it has been found that the factors affecting to the batch wise process flow implementation are; machine down time, line balancing, end-line rejection, damage occurring in a garment, needle downtime, style changing and number of machine operators available. Based on that, the research framework has been developed.

Following hypotheses have been derived from the conceptual framework.

1. H_1 - There is no impact of machine breakdowns to the batch wise process flow in the production line.
2. H_2 - There is no impact of line balancing to the batch wise process flow in the production line.
3. H_3 - There is no impact of end line rejection to the batch wise process flow in the production line.
4. H_4 - There is no impact of damage occurring in a garment to the batch wise process flow in the production line.
5. H_5 - There is no impact of needle breakdowns to the batch wise process flow in the production line.
6. H_6 - There is no impact of style changing to the batch wise process flow in the production line.
7. H_7 - There is no impact of number of machine operators to the batch wise process flow in the production line.

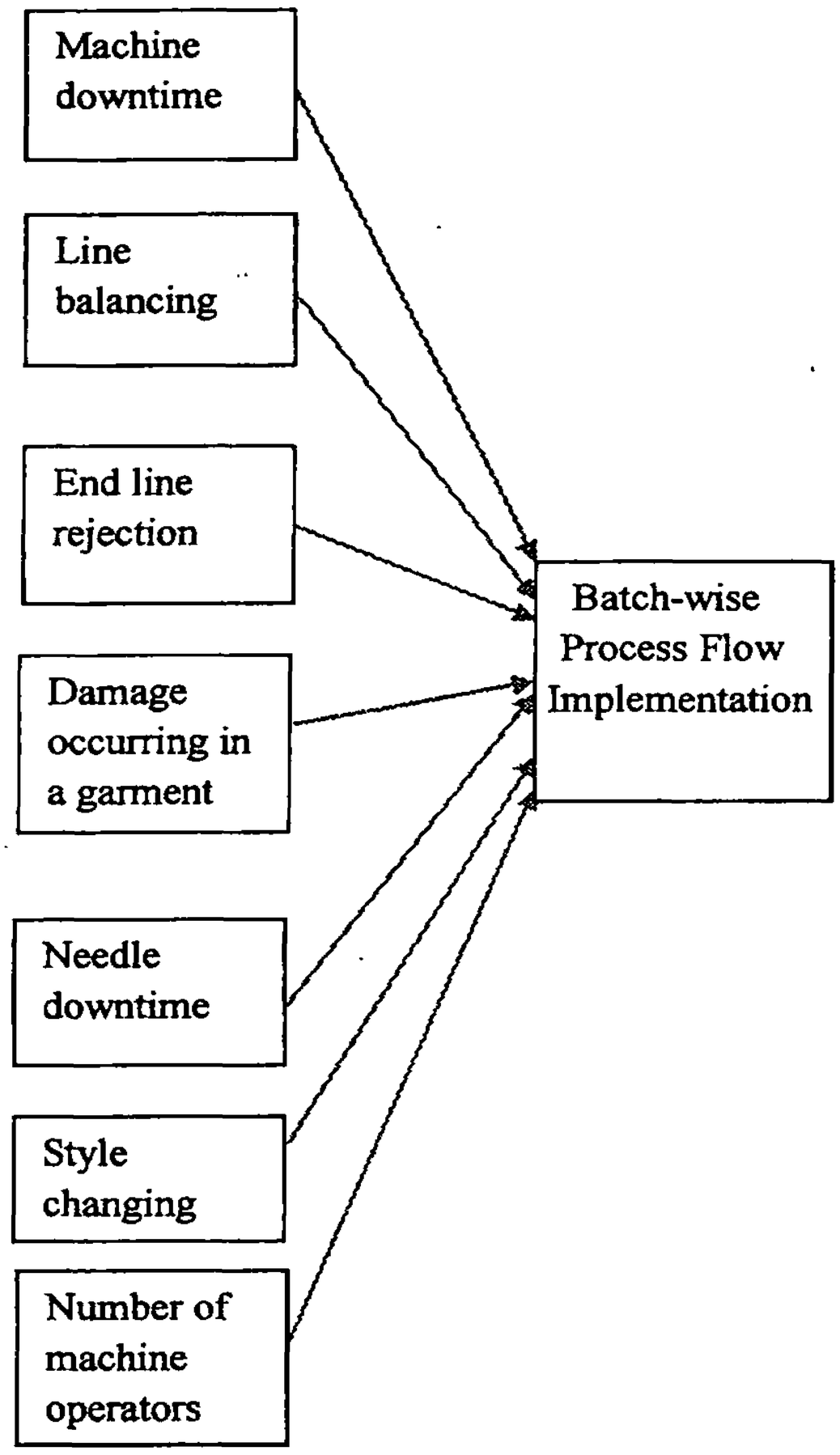

Figure 1: Research Framework

METHODOLOGY

Research design adopted for the study was a case study approach. Both primary and secondary data were collected during the study period. Out of 20 production lines, only a single production line was employed for implementing the batch-wise production process.

To measure the success or failure of batch-wise process flow implementation, WIP was selected. If WIP rate can be controlled to a minimum number, it implies that the batch-wise process flow implementation is a success. Machine downtime, line balancing, end-line rejection, damage occurring in a garment, needle

downtime, style changing and number of machine operators were taken as the independent variables. Method of data collection was mainly through the observation. To measure the line balancing the secondary data were used. Data were collected during consecutive 30 working days for two working shifts.

DATA ANALYSIS

Tests of Normality

Before a detailed analysis, it is needed to identify whether the data set follow a normal distribution. Since the sample size is 30, Shapiro-Wilk Test is more appropriate for testing the normality.

Table 1: Shapiro- Wilk Test

	Shapiro-Wilk		
	Statistic	df	Sig.
WIP	0.940	30	0.06
Machine down time	0.194	30	0.056
Line balancing	0.24	30	0.067
End-line rejection	0.332	30	0.076
Damage occurring in a garment	0.34	30	0.08
Needle downtime	0.46	30	0.078
Style changing	0.48	30	0.069
Number of machine operators	0.55	30	0.086

All independent variables and the dependent variable follow normal distribution since the significant value of Shapiro-Wilk test was greater than 0.05.

Correlation Analysis

Since all p values are < 0.05, there is a linear relationship between dependent variable and each independent variable. Line balancing and number of machine operators have negative relationship while all the other variables have positive relationship with WIP.

Table 2: Correlation Table

		Machine Down time	Needle Down time	End line rejection	Line balancing	Damage occurring	No of machine operators	Style changing
WIP	Pearson Correlation	.332	.349	.163	-.144	.292	-.222	.358
	Sig. (2-tailed)	.043	.029	.019	.047	.018	.039	.012
	N	30	30	30	30	30	30	30

Linear Regression Model

Table 3: Multiple Linear Regressions

Summary of the model		
Variables entered to fit the regression line	frequency of Machine downtime, number of End line rejection, frequency of Needle downtime, Number of machine operators available	
R^2 Value	0.57%	
Model :Coefficients Table- Sig. Value		
Constant	10.453	.255
Machine down time	0.005	.025
Line balancing	-1.008	.615
End-line rejection	0.003	.035
Damage occurring in a garment	-0.384	.475
needle downtime	0.026	.028
style changing	-0.039	.067
number of machine operators	0.061	.044

Significant values of line balancing, number of damage occurring in a garment and style changing were greater than 0.05. Therefore, with 5% level of significant,

these three variables were not included at the final model.

Based on that, the following model equation was derived.

WIP=10.453+0.005 (frequency of Machine downtime)+0.003 (number of End line rejection)+ 0.026 (frequency of Needle downtime) + 0.061 (Number of machine operators available).

57% of the variance in the WIP is explained by this model.

DISCUSSION, CONCLUSION AND FUTURE RESEARCH

The research has identified some suitable solutions for the success of batch wise process flow implementation in a production line. By reducing the level of WIP inventory, company can meet the deadlines of the orders more favorably.

Most significant factors for reducing the WIP are, reducing the frequencies of machine down time and needle down time, the number of end line rejections and the absentees of a production line. To reduce machine down time and needle down times, operators need to provide a proper training on self-maintenance and good sewing practices. Even to reduce the end line rejections, company can introduce the quality checking after each batch at the machine (one of the operation of the batch wise process).

Lean concept covers a vast area such as eliminating wastages, just in time manufacturing, 5S concept, continuous improvements, etc. Therefore, a study can be undertaken to find with implementing JIT, how it is affected to the whole manufacturing system. Also in this study, researchers did not investigate about the most effective batch size. One can undertake a study to find the most efficient or optimized batch size to be processed at the production line.

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