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PERFORMANCE IMPROVEMENT IN APPAREL MANUFACTURING USING LEAN TECHNIQUES

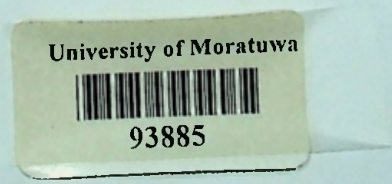
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by

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*This thesis was submitted to the
Department of Textile & Clothing Technology
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In partial fulfillment of the requirements of the
Degree of*

Master of Philosophy



**Department of Textile & Clothing Technology
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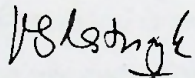
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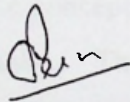
Declaration:

I hereby certify that the work incorporated in this thesis was solely carried out by me under the supervision of Dr. HSC Perera and Dr. WDG Lanarolle. No portion of work in this thesis or any material incorporated in it has not been submitted for any University or Institution for any other academic qualification.



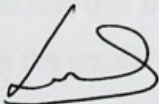
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Abstract

The labour productivity in the Sri Lankan garment industry is found to be rather low compared to that of some of its competitive countries. On site investigation revealed that the workflow gets unbalanced due to many reasons despite it is balanced at the commencement of a new style. The Work In Progress (WIP) and its fluctuation are found as two apparent factors reducing the labour productivity in addition to disorganized set-up activities during style changes. The significance of the problem of high WIP and its high fluctuation are investigated through the data collected from 42 garment manufacturing lines in 14 different factories. Hypothesis testing on these data revealed that this is a common problem across all 14 factories under this study. Root cause analysis on WIP fluctuation disclosed the major contributing factors to the problem. Identifying each sewing line in few 'sub-cells', where a team of operators focuses mainly on one part of the garment helped addressing most of the problems identified in the root cause analysis. An algorithm to balance the production line and the sub-cells is devised. The concept was successfully implemented in a garment manufacturing company in Sri Lanka. The evaluation of the performance indicators revealed that the production efficiency has increased by more than 10% while drastically reducing the defect percentage. The operator absenteeism too has significantly reduced. This may be due to the fact that the operators' motivation to work and their income are increased as disclosed by the results of the questionnaire survey among operators and the supervisors.

High, but inevitable, style changes aggravate the problem of low labour productivity as drastic production efficiency drops are experienced during the changeover. The quick changeovers concepts commonly found in lean manufacturing and newly proposed five-step set-up procedure streamlined the set-up activities. The implementation of the proposed set-up procedure made it possible to increase the average first day production efficiency of the factory over 80% and a significant reduction in the set-up times as compared with the statistics before implementation.

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CEM	Cost Per Minute
CV	Coefficient of Variation
DFMA	Design For Manufacture and Assembly
EPA	European Productivity Agency
RFQ	Request for Quote
FOA	Fixed Overhead Rate
FOB	Free On Board
GOE	Group Equipment Operator
GSD	Group Setting Data
GT	Group Technology
ILO	International Labour Organization
JAAI	Joint Apparel Manufacturers Institute
JIT	Just in Time
LCM	Learning Experience Curve Model
MFA	Multi-Factor Agreement
MTP	Method Time Measurement
MTO	Make to Order
NPS	No Fringe Exchange
NTD	No Touch Exchange Dies
OL	Over Load
OEE	Overall Equipment Effectiveness
OTED	One Touch Exchange Dies
PEAST	Process Flow Analysis and Simulation Tool
PMT	Power Management Module
PMTS	Automated Motion Time System
PO	Process Order
STED	Single Touch Exchange Dies

Abbreviations

ANOVA	Analysis of Variance
AQL	Acceptable Quality Level
BA	Button Attaching
BH	Button Hole sewing
BOI	Board Of Investment
CAD	Computer Added Design
CMA	Computerized Method Analysis
COMSOAL-PLB	Computer Method of Sequencing Operations for Assembly Lines of Assembly Planning and Line Balancing
CPM	Cost Per Minute
CV	Coefficient of Variation
DNLS	Double Needle Lock Stitch
EPA	European Productivity Agency
FIFO	First In First Out
FOA	Feed Off the Arm
FOB	Free On Board
GDP	Gross Domestic Product
GSD	General Sewing Data
GT	Group Technology
ILO	International Labour Organization
JAAF	Joint Apparel Association Forum
JIT	Just In Time
LFCM	Learning Forgetting Curve Model
MFA	Multi Fibre Agreement
MTM	Method Time Measurement
MTO	Make To Order
NFE	No Foreign Exchange
NTED	No Touch Exchange Dies
O/L	Over Lock
OEE	Overall Equipment Effectiveness
OTED	One Touch Exchange Dies
PFAST	Product Flow Analysis and Simplification Toolkit
PIM	Power Integration Model
PMTS	Predetermined Motion Time System
RC	Recency Model
SMED	Single Minute Exchange Dies

SMV	Standard Minute Value
SNLT	Single Needle Lock Stitch
SPC	Statistical Process Controller
TMU	Time Measurement Unit
TPM	Total Productive Maintenance
TPT	Through Put Time
USITC	U.S. International Trading Corporation
VR	Variance Ratio
VSM	Value Stream Mapping
WIP	Work In Progress
WRAP	World Responsible Apparel Production