OPTIMAL UTILIZATION OF MACHINES IN AN APPAREL

PRODUCTION LINE

by

KODIPPULI THANTHILLAGE DONA RASITHA RANGANI

WICKRAMASINGHE

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DECLARATION

The work described in this thesis was carried out by me under the supervision of Mr. D.D.A. Gamini and Dr. Sarath Banneheke and a report on this has not been submitted in whole or in part to any university or any other institution for any other Degree or Diploma.
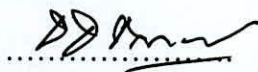
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K. T. D. R. R. Wickramasinghe

GS/MSc/IM/2881/06

We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the university for the purpose of evaluation.

Signature :   ....

Mr. D.D.A. Gamini

Senior Lecturer

Department of Statistics and Computer Science

University of Sri Jayewardenepura

Nugegoda

Signature :   ....

Dr. Sarath Banneheka

Senior Lecturer

Department of Statistics and Computer Science

University of Sri Jayewardenepura

Nugegoda

Date: 30th September 2008

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List of Abbreviations

ALBP	-	Assembly Line Balancing Problem
B&B	-	Branch and Bound
BPT	-	Batch Pitch Time
CPM	-	Cost Per Minute
CSP	-	Constraint Satisfaction Problem
EPM	-	Earn Per Minute
FVM	-	Flow time Variation Minimization
GALBP	-	General Assembly Line Balancing Problem
GRASP	-	Greedy Randomised Adaptive Search Procedure
IP	-	Integer Programming
LP	-	Linear Programming
MALBP	-	Mixed-model Assembly Line Balancing Problem
MIP	-	Mixed Integer Programming
MOEA	-	Multiple-Objective Evolutionary Algorithms
MOMA	-	Multiple Objective Memetic Algorithm
MOOP	-	Multiple Objective Optimization Problems
MTM	-	Methods-Time Measurement
SALBP	-	Simple Assembly Line Balancing Problem
SI	-	Smoothness Index
SMV	-	Standard Minute Value
SSJ	-	Stochastic Simulation in Java
TGT	-	Target

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ABSTRACT

Apparel Industry is one of the major manufacturing areas where a vast number of different resources are required in a large scale. These resources directly affect the profitability of the firm and also have been the most critical to cope. Therefore, utilization of resources has been a very demanding and common problem found in many manufacturing firms. Many researchers have focused their studies on resource utilization, but yet the demand requires more and more investigations in different ways.

This project addresses utilization of the key resources found in manufacturing firms; machines. The study has been scoped down to one of the apparel manufacturing firms in Sri Lanka to fulfill the research.

Following an extensive research on assembly lines, resource scheduling, manufacture resource planning, a mathematical optimization model of 'Zero-One Mixed Integer Programming' has been proposed with respect to the sample space of investigation. Furthermore, different methodologies of solving the proposed model also have been compared based on the characteristics of model and the model has been successfully verified.

Finally the solution steps of machine utilization have been outlined where the discussion and evaluation of the model follows the rest of the documentation to identify its suitability suggesting solutions to overcome the limitations.

Keywords: Optimization, Scheduling, Planning

1.   INTRODUCTION

1.1.   Project Background

A large amount of Sri Lankan economy and exports market share depend on the apparel Industry, representing over 43% of the total exports and contributing around 39% of the industrial production of the country. Moreover, it has helped to solve a major problem of unemployment providing more than 75% of Sri Lankan employment either directly or indirectly.   (Apparel Exporter's Association, 2007)

Our apparel industry constitutes with 830 enterprises registered with Board of Investment of the country producing textiles, high-fashion garments and accessories such as buttons, zippers, labels, etc. With the modest launch of the new horizon of the apparel industry in the country in the beginning of 1970's, Sri Lanka has been a reliable, high-quality garment supplier to many continents over the world, conforming to world standards. It has a well reputed customer base in US and Europe such as Tommy Hilfiger, Victoria's Secret, Liz Clairborne, Nike, The Gap, Marks & Spencer, BHS, Next and Mother Care.

Sri Lankan apparel industry has earned the reputation around the world due to following reasons;

- For being a quality apparel manufacturer for the mass market.
- Due to the availability of a relatively disciplined, skilled and trainable labor force.
- Compliance with international labor regulations.
- For on-time delivery of standard "all season" products.
- For providing a value for the price.

(Sri Lanka Apparel Industry, 2007)

Nevertheless, the production lines of high quality garments for the world class customers have conformed to all the ethical labor and employment regulations. Sri Lanka has signed up to 30 of the International Labor Organization Conventions, being the only Asian outsourced apparel manufacturing country having signed. Sri Lanka has also implemented a suitable ethical working environment standing against child labor and empowering the capabilities of women in the country, to uplift their lives.

(Apparel Exporter's Association)

The supporting technologies used in the apparel industry also play a major role in their quality production. The correct involvement of labor to materials and machines has become an essential key factor. A great availability of man power has become an advantage in extending the rapid growth of the industry where the worker to machine ratio of 1.8 to 1 compared to a ratio of 1.2 to 1 of its competition, highlights the fact of dependency in labor.

The modern technological usage in the industry is still in its midst of the ladder. It requires improving three categories of technologies. The 'Process and Manufacturing Technology' which serves in quick response time and efficient manufacturing process with increased quality. The second being the 'Market Technology' which focuses on new applications data capturing and data interchanging facilities such as Automatic Identification and Data Capture (AIDC), Electronic Commerce and Electronic Data Interchange (EDI) in order to improve access for the buyers into the manufacturer's site. Finally, the 'Information Technology' provides efficient management of resources aiding resource planning, scheduling and anticipating the manufacturing lines by different software supports, such as SAP, Barn and JD Edwards, to the production line. (Sri Lankan Apparel Industry, 2007)

As 'Board of Investment of Sri Lanka' (2007) highlights, the apparel industry has been crept by numerous weaknesses due to factors affected by the quota system, having a higher labor costs compared to some Asian countries such as China, Vietnam and Bangladesh, low productivity of workers, obsolete labor laws, strikes, numerous public holidays that reduce the number of effective working days, a higher lead time than international standard and also the use of archaic production methods even we are equipped with modern tools.

However, the government has already taken measures to encourage apparel manufacturers as well as to attract investors. The government has offered many facilities such as attractive tax rates, tax relief periods, and removal of tariff from equipments and capital goods. At the same time awareness programs are carried out on repositioning the apparel sector suiting for competitive market. There have also been numerous strategies toward providing resources to the industry even among youth workforce of the country. Fashion design academies have attracted many young talents as well. For an example, textile manufacturing and pattern design courses are also found in the curriculum of University of Moratuwa.

The Central Bank of Sri Lanka (2007), states that the industry sector has grown at a relatively fast rate of 7.2 per cent, mainly due to increased performance in the gem mining, food and beverage, as well as apparel sub sectors. The 'Annual Report – 2007' of Central Bank has identified a high performance of apparel exports, which have exceeded US dollars 3 billion since 2006. The same emphasizes that the major exporters of apparel have continued to focus on capacity building of the industry, in addition to the establishment of large scale knitted factories and auxiliary product manufacturing units. They have been

able to attract the international giants of the related industries as well as massive investors.

(Board of Investment of Sri Lanka, 2007)

It has been clearly highlighted in Sri Lankan Apparel (2008), the need of branding of Sri Lankan garments as a strategy of achieving a stable and consistent image among the international customer base and also makes our garment products to be preferred by them. The 'Garment Without Guild (GWG)' slogan given to the Sri Lankan apparel industry, symbolizes the synergy between ethical brands and apparel made in Sri Lanka. "Children have no business in our business" is just one of the principles governing this industry ethos. Yet it takes quite a long time to build it and manage to achieve the target like world leading brand image holders like 'Coca Cola' and 'Apple'.

The garment manufacturing sector is one of the biggest industries known to consume a vast range of resources for the production; especially in producing quality pieces of garments for international market. A careful utilization and management of these resources have been considered critical in making a profitable sale of the production. The resources are labor, raw materials, machines and equipments or even the time to meet the customer's delivery deadlines.

Resource Usage

Resource planning for a particular factory is usually carried out by a planning department of the factory, headed by the planning manager. The planning is carried out for all the types of inputs to produce the quality product.

The resource utilization needed for the factory can be considered as follows.