International Journal of Human Resources Management (IJHRM)
ISSN(P): 2319-4936; ISSN(E): 2319-4944
Vol. 3, Issue 1, Mar 2014, 59-72

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

"OPTIMIZATION OF MAN-MACHINE RATIO IN GARMENT INDUSTRY"

AMBIKA B[1] & JOSEPH REGY[2]

[1]Lecturer, Institute of Technology for Textile, Garment & Fashion Design, Bahir Dar, Ethiopia

[2]Professor, National Institute of Fashion Technology, Bangalore, Karnataka, India

ABSTRACT

Effective use of machines and manpower is essential in manufacturing of apparel products for ensuring high productivity investment from available resources in today's competitive business environment. It is thus crucial to establish optimal man-machine ratio to gain high resource utilization and profitable output.

KEYWORDS: Man Machine Ratio, Garment Industry, Productivity

INTRODUCTION

Apparel industry has an important place in the Indian economy, mainly due its contribution to export and creation of employment for millions of people. In spite of international competition, Indian apparel industry has been able to improve its export performance. The domestic market in India is growing at a steady pace. Studies from NIFT and Mckinsey have identified low productivity as one of the major stumbling block in improving the competitiveness of the industry.

The top fifteen exporting countries of apparel contributed to about % of the total apparel export. As we can see in the table 1, the top fifteen apparel-exporting nations including the developed countries and developing countries. China and Hong Kong (only for domestic export), Turkey with US$ 13.6 billion worth exports topped among the western countries, followed by Bangladesh (US10.9$), India (US$ 10.9).

As regards worlds top fifteen importing countries of apparel, European union toped with US$ 177.7 billion worth imports in the year 2008. as shown in the table united states, Japan, Russian federation, Hong Kong, china are followed from EU.

Table 1

Leading Exporters and Importers of Clothing, 2008 (Billion Dollars and Percentage)						
Exporters	**Value**	**Share in World Exports/Imports**		**Annual Percentage Change**		
	2008	**2000**	**2008**	**2000-08**	**2007**	**2008**
China a	120.0	18.2	33.2	16	21	4
European Union (27)	112.4	28.4	31.1	9	15	7
extra-EU (27) exports	27.7	6.6	7.7	10	18	12
Hong Kong, China	27.9	-	-	2	1	-3
domestic exports	2.9	5.0	0.8	-14	-26	-42
re-exports	25.0	-	-	7	10	5
Turkey	13.6	3.3	3.8	10	15	-2
Bangladesh b	10.9	2.6	3.0	10	6	23
India	**10.9**	**3.0**	**3.0**	**8**	**3**	**11**

Table 1: Contd.,

Viet Nam b	9.0	0.9	2.5	22	33	21
Indonesia	6.3	2.4	1.7	4	2	7
Mexico a	4.9	4.4	1.4	-7	-19	-5
United States	4.4	4.4	1.2	-8	-12	3
Thailand	4.2	1.9	1.2	2	-4	4
Pakistan	3.9	1.1	1.1	8	-3	3
Tunisia	3.8	1.1	1.0	7	18	5
Cambodia b	3.6	0.5	1.0	18	39	4
Malaysia a	3.6	1.1	1.0	6	11	15
Above 15	**314.4**	**78.4**	**86.9**	-	-	-
Importers						
European Union (27)	177.7	39.8	47.3	10	14	8
extra-EU (27) imports	93.1	19.2	24.8	11	14	10
United States	82.5	32.1	22.0	3	2	-3
Japan	25.9	9.4	6.9	3	1	8
Russian Federation b	21.4	1.3	5.7	30	79	48
Hong Kong, China	18.5	-	-	2	2	-3
retained imports	...	...	...	...	...	...
Canada c	8.5	1.8	2.3	11	12	8
Switzerland	5.8	1.5	1.5	8	11	12
United Arab Emirates b	5.5	0.4	1.5	27	64	10
Australia c	4.3	0.9	1.1	11	13	16
Korea, Republic of	4.2	0.6	1.1	16	15	-2
Norway	2.7	0.6	0.7	10	16	19
Mexico a, c	2.5	1.7	0.7	-4	-2	3
China a	2.3	0.6	0.6	8	15	15
Singapore	2.2	0.9	0.6	2	-3	-8
retained imports	0.9	0.3	0.2	6	16	2
Turkey	2.2	0.1	0.6	30	43	41
Above 15 d	**347.8**	**91.8**	**92.6**	-	-	-
a Includes significant shipments through processing zones						
b Includes Secretariat estimates.						
c Imports are valued f.o.b.						
d Excludes retained imports of Hong Kong, China.						

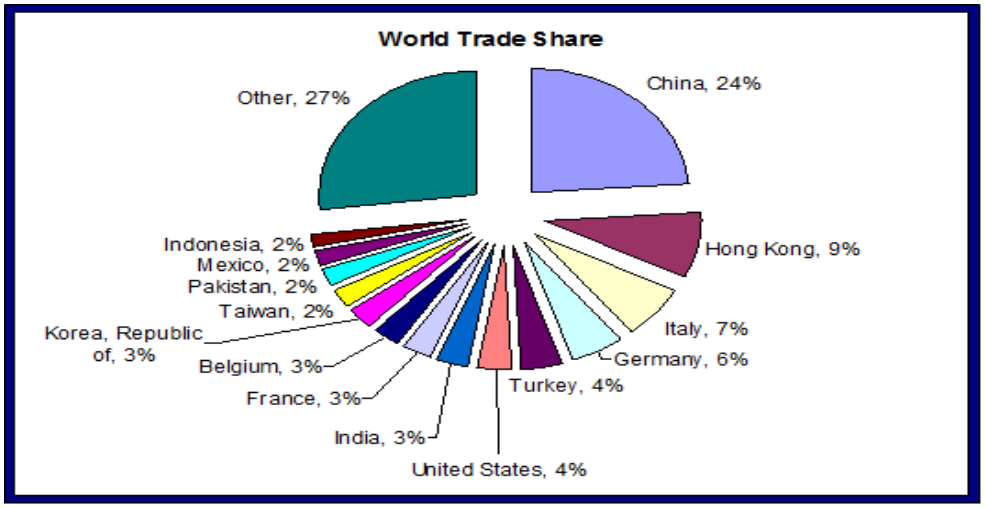
Source: International trade statistics 2008, WTO

As we can see the comparison is made for few products where we have considered the same. I am going to compare the products named cotton trouser for women rank-25, knit shirt for women- rank-22, cotton trouser for men rank-17, MMf coats for women rank 13, MMF non knit shirts for men rank-8, other cotton apparel rank-7, in this report based on man-machine ratio.

Table 2: Top Apparel Imports by the US: How India Ranks vis-à-vis its Neighbours

Category Code	Description of Category	Country				
		China	Bangladesh	Sri Lanka	India	Pakistan
348	Cotton trousers for women	Rank 5 China	Rank 8 Pakistan	Rank 17 India	Rank 25 Sri Lanka	Rank 41 Bngladesh
339	Cotton knit shirts for women	Rank 10 Bangladesh	Rank 19 China	Rank 21 Sri Lanka	Rank 22 Pakistan	Rank 35 India
347	Cotton trousers for men	Rank 5 China	Rank 7 Sri Lanka	Rank 12 Bangladesh	Rank 17 India	Rank 19 Pakistan
635	MMF* coats for women	Rank1 Bangladesh	Rank 6 China	Rank 10 Sri Lanka	Rank 13 India	Rank 26 Pakistan
359	Other cotton apparel	Rank1 China	Rank 2 India	Rank 6 Sri Lanka	Rank 7 Bangladesh	Rank 8 Pakistan
641	MMF* non-knit shirts for men	Rank 2	Rank 5	Rank 7	Rank 8	NA

Notes: *MMF: man-made fibre; NA: Not applicable.
The countries have been ranked on the basis of their share in the total US import of apparel in the respective categories.
Source: Office of US Textile and Apparel.



Source: http://www.jstor.org/pss/4414918 Economic and political weekly April 2004

Figure 1

Productivity is a measure of output from a production process, per unit of input. For example, labor productivity is typically measured as a ratio of output per labor-hour, an input. Productivity may be conceived of as a metric of the technical or engineering efficiency of production. As such, the emphasis is on quantitative metrics of input, and sometimes output.

Workforce productivity is the amount of goods and services that a laborer produces in a given amount of time. It is one of several types of productivity that economists measure. Labor productivity can be measured for a firm, a process or a country.

Measured labour productivity will vary as a function of both other input factors and the efficiency with which the factors of production are used (total factor productivity). So two firms or countries may have equal total factor productivity (productive technologies) but because one has more capital to use, labour productivity will be higher.

Output per worker corresponds to the "average product of labour" and can be contrasted with the marginal product of labour, which refers to the increase in output those results from a corresponding (marginal) increase in labour input

Operator productivity = volume of output/direct labor input (volume)

Example: operator productivity = 2000 shirts per shift/100 operator

= 20 shirt per shift

Factors Affecting Productivity

- Level of technology
- Product style, price point and production volume
- Training of workforce and management
- Motivation level of workforce and management
- Awareness of optimal productivity level
- High rate of non-first quality production
- Labor turnover and absenteeism
- Production scale
- Lead time
- Industrial engineering
- Labor relations

Production Quality per Year

This is the target production quantity per year when product specified in produce drawing is manufactured in accordance with the condition mentioned in this document.

Work Days per Year

300 days are set for work days per year.

Production Quantity per Shift

The production quantity per line X the number of lines X 1 shift = the production Quantity per shift.

Formula 1

$$\text{The production quantity per shift} = \frac{\text{Working time per shift X the number of worker}}{\text{Standard total operation time}}$$

* Each data can be calculated by applying (Formula 1)

Number of (Production) Line

Cutting Section

This is the line where the cutting carries out, where the number of people required cutting for a particular portion and the target production is calculated

Sewing Section

This is the line where actual sewing operation is made. The number of lines varies depending on item. This calculates an appropriate number of persons per line, and indicates the required number of lines for target production

quantity. When there are multiple lines, another method could be considered, namely automatic machines, fusing press machines, special equipment etc. are treated as common equipment being separate from sewing section. Treating them as common equipment will increase the operation rate of each equipment. This is judged from an appropriate production quantity of each equipment.

Finishing Section

This is the line where finished products by sewing section are complemented and reformed by supplementary works (removal of thread fray, hand stitching of buttons, hemming…), inspection, off-press, iron etc.

When there are multiple sewing lines, off-press machines and special equipment are common equipment, and finished products may be intensively processed.

Number of Shift

The number of shifts per day.

Working Time per Shift

8 Hours are set for working time per shift. (8 hours=480 minutes)

Number of Worker

The number of persons required in the sections of sewing line and finishing line. The indirect persons such as supervisors, persons for transportation are not included. The number of persons listed here is calculated subject to the workers who are highly qualified in each work of operation flow.

From (Formula 1) Formula 2

$$\text{The number of workers} = \frac{\text{Production quantity per shift X standard total operation time}}{\text{Working time per shift}}$$

Operation Time

This is the required total operation time for completing a garment spent in sections in sewing line and finishing line. This time includes time allowances, not including the time of ALT or VAR. TIME ALLOWANCE…..This is the time irregularly spent for the incidents against the regular time spent for product operation during working time, such as arrangement of products, thread change, transportation (transfer) of products, discussion for work, restroom, negligence etc. Unit is minute.

Daily Productivity (Sewing (section) only)

This is the daily productivity by direct sewing operation per worker.

In case the design changes, operation time in operation flow varies. The productivity changes accordingly.

$$\text{Daily productivity} = \frac{\text{Production quantity per shift}}{\text{Number of sewing (section's) worker}}$$

RESEARCH DESIGN

Project Title "Optimization of man-machine ratio for garment industry"

Statement of Problem: Effective use of machines and manpower is essential in manufacturing of apparel products for ensuring high productivity investment from available resources in today's competitive business environment. It is crucial to establish optimal man-machine ratio to gain high resource utilization and profitable output.

Objectives

- Optimization of man-machine ratio
- Achieving high productivity investment from available resources
- To gain high resource utilization and profitable output.

METHODOLOGY

- Study of the productivity of factories.
- Operation breakdown for selective style in manufacturing department so that process flow and manpower requirement for each could be established.
- Comprehensive detailing of manpower requirement for each operation and establishing a standard ratio based on the study
- The comparison would involve the following
  - Manpower requirement and Machinery comparisons for each operation
  - Operation productivity comparison chart
  - Comparison of profitable output on the machines and manpower.
- Analysis of man and machine ratio.
- Determination of optimized man-machine ratio for factories.
- Implementation and Suggestions.

Scope

To analyze the requirement of the garment industry and suggest the best possible infrastructure in terms of machineries and manpower keeping the productivity in mind, so that the proponent gets the best man – machine ratio. Therefore it has a very good scope of setting up a plant of apparel industry with appropriate man machine ratio.

Limitations

- Assuming same style is running in the whole factory.
- Optimization is carried out only in the production department.

Type of Research: Descriptive research

Sample Size: Woven industry = 3, Knit's = 3

Tool for Collection of Data

The collection of data is done through direct interview and telephonic conversation with the concerned people. By visiting various Woven & Knits garment industry

METHOD OF COLLECTING DATA

Both primary and secondary data is collected.

Primary Data

During visit to garment industry by observations, the primary data like products process sequence, machines used for particular operation, no of machines, no of operator, skill matrix, learning performance and optimization of man-machine ratio is carried out by using through observation, recording & collections.

Secondary Data

- Books, magazines
- Various publications of the central, state & local governments.
- Reports & publications of various associations connected with business.

Method of Analysis

- Comparison with the standard manuals
- Statistical analysis of man and machineries required for the industry.
- Analysis through charts.

Project Work

Factory 1

Company Profile

Table 3

Industry	ABC industry pvt ltd Unit-10
Type	Manufacturing& Exporting
Specialization	Woven's
Established	1978
Annual revenue	80 million USD
Employees	1000+
Machine	500+

Step 1: Calculation of Man–Machine Ratio

Table 4

Factory	Type	Lines	On Roll Manpower	10% Absenteeism	Sewing Machine	Man: Machine Ratio
ABC unit-10	woven	9.0	1164.0	1047.6	522.0	2.01

Step 2: Break up of on – Roll Manpower

Table 5

	TIPL-10
Manager	2
Quality Assurance	9
Sampling	8
IE	9
Trainnee	9
Dispatch	7
HR	10
Fabric	6
Maintance	8
Store	5
Other	8
Cutting Section	**130**
Sewing Section	**670**
Finishing	**283**

Step 3: Break up of Production Sector

Table 6

CUTTING	Number of operators	72
	Number helpers	36
	Number of checkers	9
	Number of supervisor	13.5
SEWING	Number of operators	441
	Number helpers	81
	Number of ironers	108
	Number of checkers	27
	Number of supervisor	13.5
FINISHING	Number of operators	63
	Number helpers	162
	Number of ironers	45
	Number of supervisor	13.5

Step 4: Time Study for Cutting Annexsure-1a

Step 5: Time Study for Sewing Annexsure-1b

Step 6: Time Study for Finishing Annexsure-1c

Step 7: Productivity Calculation for Shirt Manufacturing Sector

Step 7a: Cutting Productivity

Table 7

Sl. No	CUTTING Particulars	TPIL-10
	Target	1000
1	Number of machines	8
2	Number of operators	8
3	Number helpers	4
5	Number of checkers	1
6	Number of supervisor	1.5
7	Duration of work shift	480

Table 7: Contd.,

8	SAM of Shirt (sewing)	1.9
9	Average daily output (per shift)	700
10	Operator Productivity	88
11	Productivity Effeciency /Operator	35
12	Total Labour Productivity(pcs per shift)	48.3
13	Machine Productivity	87.5

Step 7b: Sewing Productivity

Table 8

Sl. No	SEWING Particulars	TPIL-10
	Target	1000
1	Number of machines	49
2	Number of operators	49
3	Number helpers	9
4	Number of ironers	12
5	Number of checkers	3
6	Number of supervisor	1.5
7	Duration of work shift	480
8	SAM of Shirt (sewing)	30.92
9	Average daily output (per shift)	761
10	Operator Productivity	16
11	Productivity Effeciency /Operator	100
12	Total Labour Productivity(pcs per shift)	10.2
13	Machine Productivity	15.5

Step 7c: Finishing Productivity

Table 9

Sl. No	Finishing Particulars	TPIL-10
1	Number of machines	15
2	Number of operators	7
3	Number helpers	18
4	Number of ironers	5
6	Number of supervisor	1.5
7	Duration of work shift	480
8	SAM of Shirt (sewing)	4.62
9	Average daily output (per shift)	83
10	Operator Productivity	12
11	Productivity Efficiency /Operator	11
12	Total Labour Productivity(pcs per shift)	1.8
13	Machine Productivity	5.5

Step 8

- **Comparison of Each Operation with JUKI Annexure -1d**

  Based on SAM, no of MANPOWER, no of MACHINE

Table 10

SAM	17.84	30.924
MANPOWER	48	73
MACHINES	38	49
TARGET	1200	1200
ACHIVED	1076	760

Step 9: Implemented Results in ABC-10

- For Allocation of manpower ,with the help of skill matrix is carried out –Annexsure-1e
- Few attachments where used like the
    - Automatic garment stacker
    - Collar folder
    - Cuff folder
    - Sleeve placket holder
    - Automatic pocket seeker

- Results

Table 11

Sl. No	SEWING Particulars Target	TPIL-10 1000
1	Number of machines	40
2	Number of operators	40
3	Number helpers	6
4	Number of ironers	0
5	Number of checkers	3
6	Number of supervisor	1.5
7	Duration of work shift	480
8	SAM of Shirt (sewing)	23.92
9	Average daily output (per shift)	800
10	Operator Productivity	20
11	Productivity Effeciency /Operator	97
12	Total Labour Productivity(pcs per shift)	16
13	Machine Productivity	20

If it can happened for 1 line then for the factory

IMPLEMENTATION RESULTS

Man: Machine ratio

Table 12

Factory	Type	Lines	On Roll Manpower	10% Absenteeism	Sewing Machine	Man: Machine Ratio(E/F)
ABC unit-10	wovens	9.0	1164.0	1047.6	522.0	2.01
ABC unit-16	wovens	9	708	637.2	365	1.75

Table 13

Operator Productivity	16	20
Productivity Effeciency /Operator	100	97
Total Labour Productivity(pcs per shift)	10.2	16
Machine Productivity	16	20

Factory-2

Company Profile

Table 14

Industry	XYZ apparel Pvt,ltd
Type	Manufacturing& Exporting
Specialization	Woven's
Annual revenue	80 million USD
Employees	**800+**
Machine	**300+**

Step 1: Calculation of Man –Machine Ratio

Table 15

Factory	Type	Lines	On Roll Manpower	10% Absenteeism	Sewing Machine	Man: Machine Ratio(E/F)
XYZ apparels pvt	wovens	6	830	747.0	320	2.33

Step 2: Break up of on – Roll Manpower

Table 16

	XYZ Apparels Pvt Ltd
Manager	2
Quality Assurance	5
Sampling	10
IE	10
Trainnee	10
Dispatch	5
HR	10
Fabric	5
Maintance	7
Store	5
other	8
Cutting Section	**99**
Sewing Section	**453**
Finishing	**201**

Step 3: Break up of Production Sector

Table 17

CUTTING	Number of operators	54
	Number helpers	24
	Number of checkers	12
	Number of supervisor	9
SEWING	Number of operators	312
	Number helpers	72
	Number of ironers	30
	Number of checkers	30
	Number of supervisor	9
FINISHING	Number of operators	48
	Number helpers	114
	Number of ironers	30
	Number of supervisor	9

Step 4: Time Study for Cutting Annexsure-2a

Step 5: Time Study for Cutting Annexsure-2b

Step 6: Time study for Cutting Annexsure-2c

Step 7: Productivity Calculation for Shirt Manufacturing Sector

Step 7a: Cutting Productivity

Table 18

Sl. No	CUTTING Particulars TARGET	XYZ Apparels Pvt Ltd 1200
1	Number of machines	9
2	Number of operators	9
3	Number helpers	4.0
5	Number of checkers	2.0
6	Number of supervisor	1.5
7	Duration of work shift	480
8	SAM of Shirt (sewing)	2.1
9	Average daily output (per shift)	750.0
10	Operator Productivity	83
11	Productivity Effeciency /Operator	36
12	Total Labour Productivity(pcs per shift)	45.5
13	Machine Productivity	83.3

Step 7b: Sewing Productivity

Table 19

Sl. No	SEWING Particulars Target	TPIL-10 1000	XYZ Apparels Pvt Ltd 1040
1	Number of machines	49	52
2	Number of operators	49	52
3	Number helpers	9	12.0
4	Number of ironers	12	5.0
5	Number of checkers	3	5.0
6	Number of supervisor	1.5	1.5
7	Duration of work shift	480	480
8	SAM of Shirt (sewing)	30.92	32.4
9	Average daily output (per shift)	700	750
10	Operator Productivity	14	14
11	Productivity Effeciency /Operator	92	97
12	Total Labour Productivity(pcs per shift)	9.4	9.9
13	Machine Productivity	14.3	14.4

Step 7c: Finishing Productivity

Table 20

Sl No	FINISHING Particulars	XYZ Apparels Pvt Ltd
1	Number of machines	8
2	Number of operators	8

Table 20: Contd.,

3	Number helpers	19.0
4	Number of ironers	5.0
6	Number of supervisor	1.5
7	Duration of work shift	480
8	SAM of Shirt (sewing)	6.1
9	Average daily output (per shift)	63
10	Operator Productivity	8
11	Productivity Effeciency /Operator	10
12	Total Labour Productivity (pcs per shift)	1.5
13	Machine Productivity	7.9

Step 8: Comparison of Each Operation with JUKI

Comparison of Each Operation with JUKI Annexure -2d

Based on SAM, no of MANPOWER, no of MACHINE

Table 21

SAM	17.84	30.2
MANPOWER	48	75
MACHINE	38	47
TARGET	1200	1200
ACHIVED	1022	747

Step 9: Suggestion

- For Allocation of manpower, with the help of skill matrix is carried out –Annexsure-2e
- Few attachments where used like the
  - Use of Automatic garment stacker
  - Use of Collar folder
  - Use of Cuff folder
  - Use of Sleeve placket holder
  - Use of Automatic pocket seeker
  - Use of Proper allocation of manpower
  - Use of Training program for operators
  - Used of Motivation for the operators like the incentive schemes based on the performance
  - Use of barcode system to track the product and also operator productivity can be traced easily
  - Use of comfortable ergonomically designed chairs for the operators
  - Playing of pleasant music after the lunch break
  - Education about the product ,work
  - If they face some injustice then there should be a suggestion box to drop or counseling should be carried out every month during the leisure time

If it can reduce in the 1 line then in the whole factory

Table 22

Operator Productivity	14	20
Productivity Effeciency /Operator	97	104
Total Labour Productivity(pcs per shift)	9.9	14.2
Machine Productivity	14.4	20.0

Table 23

Factory	Type	Lines	On Roll Manpower	10% Absenteeism	Sewing Machine	Man: Machine Ratio(E/F)
XYZ	wovens	6	830	747.0	320	2.33
XYZ	wovens	6	615	553.5	320	1.73

CONCLUSIONS

For Allocation of manpower, with the help of skill matrix is carried out Few attachments where used like the Use of Automatic garment stacker, Use of Collar folder, Use of Cuff folder, Use of Sleeve placket holder, Use of Automatic pocket seeker, Use of Proper allocation of manpower, Use of Training program for operators ,Used of Motivation for the operators like the incentive schemes based on the performance, Use of barcode system to track the product and also operator productivity can be traced easily and few thinks like Use of comfortable ergonomically designed chairs for the operators, Playing of pleasant music after the lunch break, Education about the product ,work, If they face some injustice then there should be a suggestion box to drop or counseling should be carried out every month during the leisure time. By doing the above things the operator productivity increase approximately by 1/4 %, Productivity Efficiency /Operator by 1%, Total Labor Productivity (pcs per shift) by 1.4% and machine Productivity by 1.4% and overall man machine ratio reduced from 2.33 to 1.73.

REFERENCES

1. Source: International trade statistics 2008, WTO
2. Source: http://www.jstor.org/pss/4414918 Economic and political weekly April2004
3. Goldratt 1999
4. Case study 1; **Intel Assembly and Test manufacturing**
5. **Case study 2; Clark Ecozone's Garment Industry: The Need to Upgrade**
6. *Technical Education and Skills Development Authority. (2000). Clark Ecozone's Garment Industry: The Need to Upgrade. Retrieved July 22, 2005 from the World Wide Web: http://www.tesda.gov.ph/services/info/info2.html*
7. Article of Rajesh Bheda
8. Managing Productivity in the Apparel Industry by Rajesh Bheda
9. Source:http://ezinearticles.com/?Overview-of-Bangladesh-Garment-industry&id=367773
10. *http://www.just-style.com/article.aspx?id=95318*