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Aspects of Productivity in Cotton Spinning

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Abstract
The factors which influence the production of spinning mills are raw material, labour, machinery, maintenance, energy use, and humidity. In this paper, labour and machine productivity are studied, and the results are compared with SITRA standard 2010 for measuring productivity. The study is based on primary and secondary data collected from the case factories at the same period of time. Data is analysed based on the South India Textile and Research Association standard for spinning mills. According to the institute, labour productivity indices are the number of operative hours required to produce 100 kgs of yarn (HOK), operatives per 1000 spindles (OHS), and composite productivity index (CPI). Machine productivity indices are production per spindle (P), spindle utilization (SH), and machine productivity index (MPI). The result shows lower indices for both factories as compared to the standard. The reasons for low productivity were also investigated. The labour productivity is affected by inefficiency and lack of skills of operators. The machine efficiency is 80-90%. Analysis of ring frame indicated various individual spindle and working stoppages. Power interruption and roving shortage accounts for 23% and 9% of the total down time respectively. These factors affect the productivity to a great extent in both factories.
Key words: *Labour, Machine, Productivity, Spinning.*

I. INTRODUCTION

Productivity is the ratio of output to input. Productivity denotes the efficiency with which the various inputs are transformed into goods and services. Productivity is said to be high when more output is derived from the same input. Productivity denotes trend of productiveness of the factors of production, labour, materials, and capital. Usually its trend is identified as a measure, a ratio or a rate of return, a relationship between output and input over a period of time [1]. High productivity refers to doing the work in the shortest possible time with least expenditure on inputs without sacrificing quality and with minimum wastage of resources [2].
Productivity demands better, cheaper, quicker, easier and safer ways of manufacturing a product. It aims for maximum utilisation of resources (men, machines, money, power, land, capital, etc.). A study of productivity indicates factories’ profitability status. This is crucial to control overall costs of production [1, 9].
Productivity can be measured in two ways: total and partial. Total productivity is based on all the inputs whereas partial productivity depends upon each individual input. The model can be applied to any manufacturing organisation or service company [2, 11].
As per different surveys conducted, the efficiency of the spinning section of Ethiopian textile factories does not exceed 50% and quality of the yarn sub-standard [3]. Even though there are about 38 spinning mills at present [4, 8], the factories’ productivity is not measured using standards. Therefore, the current productivity status of two proposed factories is studied. The reasons for poor performance of spinning and areas of improvement are also analysed and presented.

II. METHODOLOGY

Two factories were selected for the study of labour productivity and machine productivity. They have 28 tons/day installed capacity which is 10% of the country’s total capacity. The factories produce different counts of yarn ranging from 10s – 32s ring carded yarn and open end yarn.
The steps followed were: process analyses, measuring productivity, and comparing with the SITRA standard 2010 [5]. SITRA standard encompasses the study of process, quality, waste, productivity, finance and cost, energy, and store consumption parameters for intermediate and final products for different spinning systems [6]. Data were collected in the same period for the two factories. This information was based on assessing labour productivity and machine productivity. So, to study the two productivity factors, it was necessary to set assessment technique and standard for spinning.
Detailed primary as well as secondary data were collected. Primary data included monthly production, machine details, etc. Secondary data comprised spindle shifts worked, number of working days, category-wise operatives engaged, work assignments being followed, and down times. In order to compare the data with the standard, the production and labour values have to be adjusted for comparison.
The method consists of adjusting the various productivity parameters to 40s count. A mill can compare its productivity between months and also judge its performance against SITRA standard, regardless of the differences in the counts being produced. The standards are fixed such that they reflect the productivity levels being attained or excelled by the top 10% of the mills in the industry. The revised SITRA standards for number

of operative hours required to produce 100 kgs of yarn (HOK) and operatives per 1000 spindles (OHS) are used [7].

III. RESULTS AND DISCUSSION

Spindle Utilization

It is calculated by dividing the average spindle hours worked per day by the installed spindles. In Bahir Dar Textile Share Company (BDTSC), the total spindles worked in March 2015 in all shifts were 544,410. The calculated spindle utilization was 20.52 hours/day. In Kombolcha Textile Share Company (KTSC), the total spindles worked in the same period were 270,935. The calculated spindle utilization was 23.42 hours/day.

Production per Spindle per 8 Hours (P), Adjusted to 40s Count

To obtain production per spindle per 8 hours, adjusted to 40s count, the production in each count is multiplied by the respective conversion factor for that count as shown in Table 1. The products so obtained are summed; the sum is divided by the total number of spindle shifts worked during the day. The calculated production was 67.80 gm/shift and 92.08 gm/shift for BDTSC and KTSC respectively.

Table 1. Conversion Factors for Standardized Production

Count	16s	20s	21s	30s
Production/Spindle	0.332	0.420	0.452	0.692
Mixing Attendants	1.03	1.00	1.00	1.00
Blow Room Tenter	1.04	1.00	1.00	1.00
Card Tenter	1.00	1.00	1.00	1.00
Draw Frame Tenter	0.93	0.93	0.93	0.97
Fly Frame Tenter	1.07	0.98	0.98	1.14
Fly Frame Doffer	0.88	1.00	1.00	1.00
Ring Frame Tenter	0.55	0.70	0.56	0.86
Ring Frame Doffer	0.77	0.83	0.83	1.00
Other Operatives	0.58	0.50	0.54	0.83
Total	**0.69**	**0.71**	**0.69**	**0.91**

Source: SITRA norms 2010

HOK, adjusted to 40s Count

The count-wise, raw material-wise and category-wise HOK conversion factors for each sub-section are given in conversion Table 1 made by SITRA 2010. In all industries, the importance of labour cannot be denied [12]. But in the textile sector, especially in spinning mills, labour plays a very crucial role because without their participation, nothing could be done. As observed in Table 2, the total HOK of BDTSC and KTSC is 3 and 1.976 respectively, but the standard is 1.65. This indicates that BDTSC takes more time to produce 100 kg of yarn. As compared to BDTSC, KTSC takes less time. The two factories must do different activities to enhance their labour productivity.

$$HOK\ (adjusted) = \frac{Operative\ hours}{\sum count - wise\ standardized\ ring\ frame\ production} \quad (1)$$

$$OHS = \frac{HOK\ X\ P}{800} \quad (2)$$

Table 2. Category-wise SITRA Standard HOK against BDTSC and KTSC

S. No.	Category	SITRA standard		BDTSC		KTSC	
		HOK	OHS	HOK	OHS	HOK	OHS
1	Mixing attendant	0.6	0.08	1.49	0.13	0.43	0.049
2	Blow room operator	0.2	0.03	0.99	0.08	0.21	0.025
3	Carding Operator	0.2	0.03	1.14	0.10	0.34	0.039
4	Draw frame operator	0.3	0.04	1.28	0.11	0.45	0.052
5	Fly frame operator	0.4	0.06	1.85	0.16	0.87	0.100
6	Fly frame doffer	0.5	0.07	1.68	0.14	0.32	0.037
7	Ring frame operator	3.1	0.42	14.49	1.23	7.57	0.872
8	Ring frame doffer	2.7	0.37	-	-	-	-
9	Other operatives	4.0	0.55	9.74	0.83	6.98	0.803
10	**Total**	**12**	**1.65**	**32.66**	**2.76**	**17.17**	**1.976**
Production per spindle per 8 hours adjusted to 40s (gm)			**110**	**67.80**		**92.08**	

Source: the column entitled “SITRA standard” is extracted from SITRA norms 2010

Composite Productivity Index (CPI)

Composite productivity index is calculated by expressing the standard total HOK 12 as a percentage of the actual HOK. It is 33.86 and 54.16 for BDTSC and KTSC respectively.

Machine Productivity Index (MPI)

MPI is a combined measure of production per spindle and spindle utilization. According to SITRA 2010, it is calculated using the formula below:

$$MPI = \frac{P \, x \, SH}{110 \, x \, 24} x100 \quad (3)$$

Where, P is production per spindle per shift and SH is spindle hour

The MPI values are 60.15 and 71.57 for BDTSC and KTSC respectively.

Table 3. Summary of Productivity Figures

S. No.	Parameter	BDTSC	KTSC	SITRA Standard	Remarks	
					BDTSC	KTSC
1	Total OHS	3	1.976	1.65		
2	Total HOK	35.43	17.17	12.0		
3	CPI	33.86	54.12	100	About 66% lower	About 46% lower
4	P (in gm)	67.80	92.08	110	About 38% lower	About 16% lower
5	MPI	60.15	71.57	100	About 40% lower	About 29% lower

As observed in Table 3, the machine productivity of the two factories is low compared to SITRA standard. While analysing the ring frames, there are different working stoppages due to ends down, doffs, and creeling. These factors affect the productivity to a great extent. Figure 1 shows loss of production due to down time (spindle stoppage). In addition, consumable spares critical in achieving production and quality are not replaced in time as per manufacturers' recommendation [13-14].

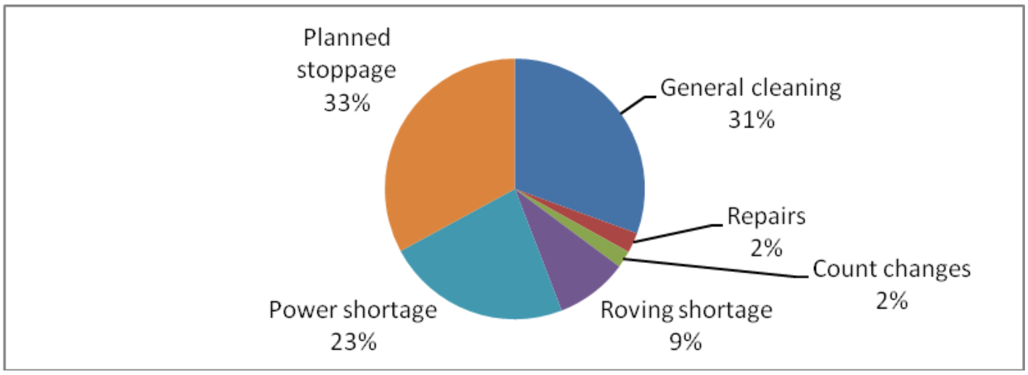

Fig 1. Reasons for Spindle Stoppages

The underlying causes for low labour productivity are lack of enthusiasm due to unavailability of incentive package and limited skills of operators. Irregular shaped cops and bad piecing practices are also observed. An end will fail in spinning when the tension in the balloon exceeds the strength at the weakest point in the yarn [10]. As shown in Table 4, the end breaks per 100 spindle hours is high in the two factories, which reduces productivity. Moreover, the time required to mend each end breaks is 6.8 seconds and 5.4 seconds for BDTSC operators and KTSC operators respectively. This increases the amount of pneumafil waste.

Table 4. End breaks/100 spindle hours

S. No.	Count	End breaks/100 spindle hours		
		Standard	BDTSC	KTSC
1	16s	7.8	_	12.5
2	20s	9.8	_	15.7
3	21s	9.6	_	15.4
4	30s	8.0	_	12.8
5	32s	7.9	19.3	
6	40s	8.8	_	_

Furthermore, the working environment affects labour productivity. During the study, it is observed that the lighting system of the sections is poor. It should be improved in order to facilitate the working conditions in all sections. It is also advisable to close the waste filter room to prevent dust leakage to the production line since it affects the operators' performance and health as well as creates temperature and humidity disturbance.

IV. CONCLUSION

The results show that HOK is 35.43 and 17.17 for BDTSC and KTSC respectively. In addition, production per spindle per shift for BDTSC and KTSC is 67.8 gm and 92.08 gm respectively. Based on these data, KTSC is performing better as compared to BDTSC. The major causes for low machine productivity are power interruption, roving shortage, and count change. Time wastage during planned stoppage and general cleaning has its own share. To improve labour productivity, it is better to recruit properly skilled workers. Secondly, arrange training sessions for skill improvement from time to time. Last, but not least, provide monetary incentives to boost employee morale.

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