IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE)
e-ISSN: 2348-019X, p-ISSN: 2348-0181, Volume 6, Issue 6 (Nov. - Dec. 2019), PP 07-13
www.iosrjournals.org

Evaluating the Co-relation among the Parameters of Circular Weft-Knitting Machine

Taslima Ahmed Tamanna[1], Md. Rubel Alam[2*], Sabbir Rahman Abir[3], Md. Shariful Islam[4]

[1]*Department of Textile Engineering, BGMEA University of Fashion & Technology (BUFT), Dhaka, Bangladesh*
[2*]*Department of Knitwear Manufacturing &Technology, BGMEA University of Fashion & Technology (BUFT), Dhaka, Bangladesh*
[3]*Department of Apparel Merchandising & Management, BGMEA University of Fashion & Technology (BUFT), Dhaka, Bangladesh*
[4]*School of Materials Science and Engineering, University of New South Wales, Sydney, Australia*

Abstract: *This paper summarizes the effects of production parameters of knitting section. The investigations have been conducted on two knitting machines namely Wellknit and Pailung. Yarn breakage rate with respect to yarn count, type of yarn, rpm and number of feeders of the machine have been analyzed. Moreover, fabric production rate with respect to machine diameter and machine rpm were investigated. Finally, the production cost of a knitting machine with respect to machine diameter was analyzed. Result reveals the direct proportional relation between rpm with production, yarn tension, breakage and inverse relations with machine diameter and yarn count. However, yarn breakage inversely related with machine efficiency. Also, yarn count and yarn type (KH/CH) affects production.*

Keywords: *Knitting, Production, Breakage Rate, RPM, Yarn type, Yarn Count.*

Date of Submission: 02-12-2019 Date of Acceptance: 18-12-2019

I. Introduction

The demand of the knitted garments has been increased in a geometric progression during the recent years, because of easy production technique, low cost, product versatility and inherent comfort ability (Management and Science, 2009)(Siddika *et al.*, 2017). Over the last two decades, technical development in machines and software has been come into market and industry as well (Peterson and Ekwall, 2007). For this reason, a large number of knitting factories are involved in the manufacturing streamline of fabrics in Bangladesh and become the prime driving force of export earnings along with generating employment(Solaiman *et al.*, 2014). However, the current knitting industry is facing stiff global competitions of produced fabric to meet the qualities and cost as well.

Although quality is a state of mind but it relates with first visualization and repetitive end uses by someone. With this purpose, several solutions are presently proposed by industry manufacturers which provide a very complete and valuable set of information and consequently improving quality and minimizing the production costs (Catarino *et al.*, 2004)(Lek-uthai, 1999).

Yarn is a continuous strand of interlocking fibers held together by twisting. End breakage is not only reduces the running efficiency but also deteriorate the quality of end products(Das and Ishtiaque, 2004). The smooth running of the knitting machine depends on yarn quality, knitting machine conditions and knitting production conditions(Reza, 2015). Carded and combed (*Ring spinning process*) both type of yarn can be used for knitting production according to buyer requirements but breakage rate significantly more to carded yarn (Siddika *et al.*, 2017)(http://www.textiletoday.com.bd) . Textile science tells yarn breakage significantly become high with increasing yarn count in indirect system.The performance of the knitting room has assumed critical importance especially with regard to the production along with fault free fabrics. The profitability and sustainability of knitting factories are influenced and depends on overall productivity through quality fabrics.

This work was undertaken to investigate the yarn breakage rate with respect to yarn count, type of yarn, rpm and number of feeders of the machine. Moreover, fabric production rate with respect to machine diameter and machine rpm were investigated. Finally, the production cost of a knitting machine with respect to machine diameter was analyzed to provide a fruitful suggestion to get high production with low cost.

II. Materials and Methods

Machine and Material Selection:

In this work, the following two types of single jersey weft knitting machine of various diameters (respectively 18, 24, 28, 30 and 32) were used. It is well known that feeder numbers will be varied due to variables diameters.

Name of brand: Pai-lung	Name of brand: Well knit
Origin: Taiwan Manufacturing year: 2006	Origin: Taiwan Manufacturing year: 2002

To accomplish the whole work, basic plain single jersey fabrics were manufactured using 18, 24, 28, 30,32 KH 100 % cotton and also 30 CH 100% cotton yarn were used.

Data Collection Principles

Since the work has been conducted in export oriented knitting factory. So, prior to discuss with knitting expert, the dependent and independent knitting variables are taken for data collection for the same structured fabric whereas the other variables were extraneous. The quality was checked by some quality expert as subjective manner and listed. After that, effects of different factors on breakage rate, production efficiency, defects etc. are presented by graphical representation. The following expression has been followed for production calculation:

Total number of needles= π x Machine diameter x Machine gauge

Total number of stiches produced per hour = No of needles x RPM x 60 x No of feeder x Efficiency

Length of yarn converted into stiches= Total no of stitches per hour x stitch length

Weight of yarn converted into fabric in lbs.

$$= \frac{\text{Length of yarn converted into stiches per hour in yds}}{840 \text{ x Yarn count (Ne)}}$$

So, the production (lbs. per hour) can be written as

$$= \frac{\pi \text{ x Machine diameter x Machine gauge x RPM x 60 x No of feeder x Efficiency x Stitch length (inch)}}{840 \text{ x Yarn count (Ne) x 36}}$$

Fabric in kg/hrs.= $\frac{F\times \boldsymbol{RPM}\times 60\times \eta\times N\times Sl\times 1.09}{1000\times 840\times Ne\times 2.204}$

Here,

Ne= English count

SL= stitch length in mm

N= Number of needles

F= Number of feeders

η= Efficiency

III. Result and Discussions

3.1 The relationship between breakage rate and yarn count has been tabulated in Table 1 and graphically shown in Figure 1.

Table 1: Breakage Rate vs. Yarn Count with Machines Efficiency

No	*Brand*	*Dia*	*G*	*N*	*F*	*SL*	*Ne*	*η*	*Breakage/hr*	*RPM*	*Prod^n in kg/hr*
1	Pai-lung	32	24	2400	96	2.66	**40**	0.75	**5**	30	12.18
2							**34**	0.8	**4**		15.28
3							**30**	0.85	**3**		18.40
4							**28**	0.85	**3**		19.72
5							**24**	0.9	**2**		24.36
6							**18**	0.95	**1**		34.28

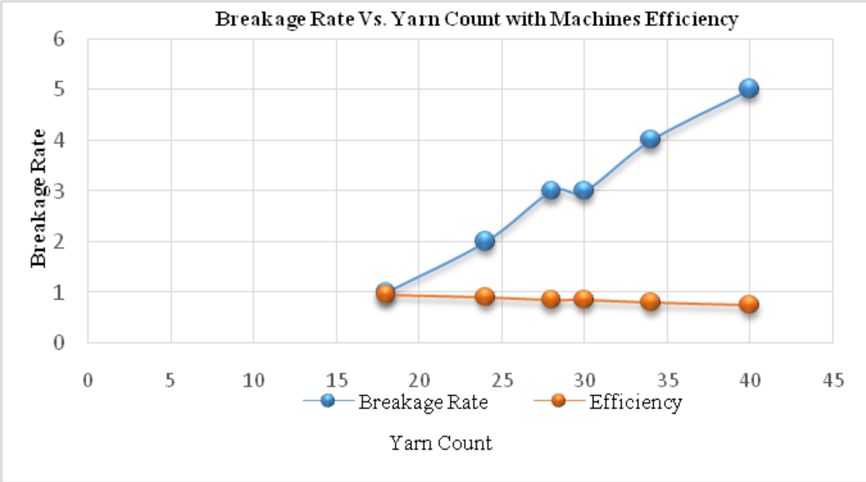

Figure 1: Breakage Rate vs. Yarn Count with Machines Efficiency

It may be assumed that end breakage rate is an important parameter which influences the fabric production and quality. Figure 1 depicts, number of yarn breakage rate is increasing with increasing yarn count (Ne) and hence decreasing the efficiency of machine. Since, indirect count indicates more fineness with higher count and it cannot tolerate the force required to pass through guide bar to knitting zone, hence breaks repeatedly.

On the other side of graph, efficiency is being down with increasing yarn counts due to the stoppage of machine. Figure shows, maximum efficiency has been obtained for 18 $^{S}/_{1.}$

3.2 The relationship between breakage rate and type of yarn has been tabulated in Table 2 and graphically shown in Figure 2.

Table 2: Breakage Rate vs. Yarn Type

No	*Brand*	*Dia*	*G*	*N*	*F*	*SL*	*Ne*	*Type*	*η*	*Breakage/hr*	*RPM*	*Prod^n in kg/hr*
1	Pai-lung	32	24	2400	96	2.7	40	**Combed Yarn**	0.75	**5**	30	12.18
2							30		0.8	**4**		17.32
3							24		0.9	**2**		24.36
4							40	**Carded Yarn**	0.65	**7**		10.55
5							30		0.75	**5**		16.24
6							24		0.85	**3**		23.00

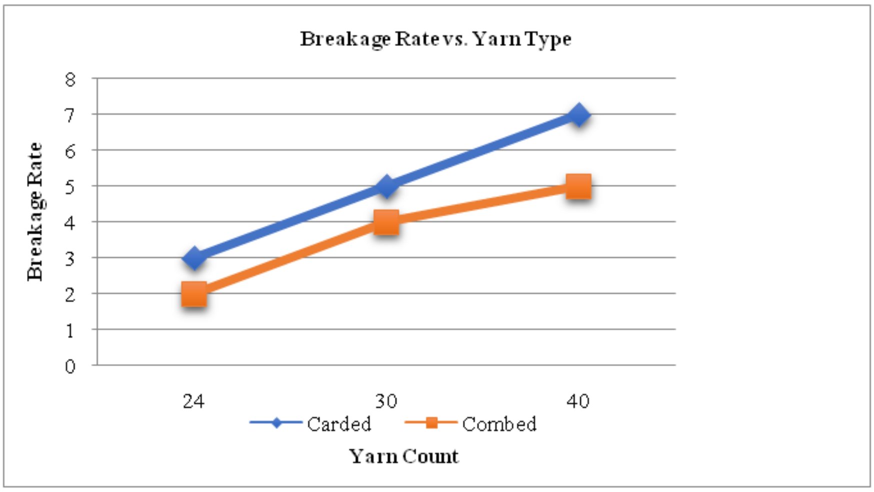

Figure 2: Breakage Rate vs. Yarn Type

Figure 2 shows the number of breakage rate of combed yarn is less than carded yarn. Theory explains, end breakage rate depends upon the fiber length (longer the fiber, lower the end breakage rate). In carded yarn, the amount of short fiber percentage is very high, whereas short fiber removed as a noil in case of combed yarn. Combed yarn strength is better than carded yarn due to less amount of short fiber in yarn axis.

3.3 The relationship between breakage rate and type of yarn has been tabulated in Table 3 and graphically shown in Figure 3.

Table 3: Breakage Rate vs. RPM

No	Brand	Dia	G	N	F	SL	Ne	η	Breakage/hr	RPM	Prod^n in kg/hr
1	Pai-lung	32	24	2400	96	2.66	30	0.9	2	25	16.28
2								0.85	3	32	19.7
3								0.8	4	45	25.98
4								0.7	6	50	25.26
5								0.6	8	55	23.81

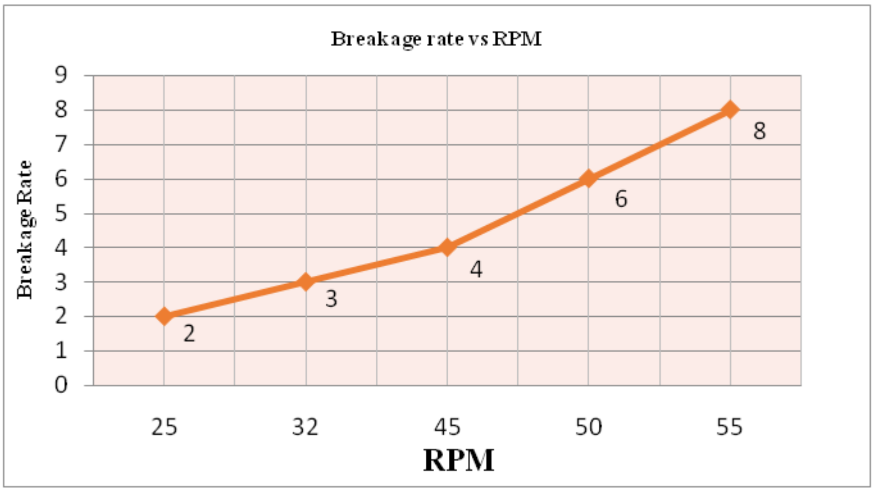

Figure 3: Breakage Rate vs. RPM

Scientist's correlates, yarn input tension strongly affects robbing back, although it occurs even at zero input tension. When the input tension is increased, it then becomes possible for the needle at the knitting point to rob yarn from two needles until an input tension is reached where the yarn breaks out (Ghosh and Banerjee, 1990)(Knapton and Munden, 2007)(Duru, Candan and Mugan, 2015)Here, high RPM leads to sudden robbing back and yarn gains tension. So that breakage rate will be more.

3.4 The relationship between breakage rate and yarn count has been tabulated in Table 4 and graphically shown in Figure 4.

Table 4: Feeder vs. Yarn Breakage

No	Brand	Dia	G	N	F	SL	Ne	η	Breakage/hr	RPM	Prodn in kg/hr
1	Pai-lung	32	24	2400	96	2.66	30	0.85	3	34	20.86
	Wellknit							0.9	2	24	15.59
2	Pai-lung	30		2256	90			0.85	3	36	19.46
	Wellknit							0.9	2	25	14.31
3	Pai-lung	28		2088	84			0.8	4	40	17.58
	Wellknit							0.9	2	27	13.35
4	Pai-lung	24		1800	72			0.75	5	46	14.00
	Wellknit							0.85	3	34	11.73
5	Pai-lung	18		1344	54			0.7	6	54	8.59
	Wellknit							0.8	4	40	7.27

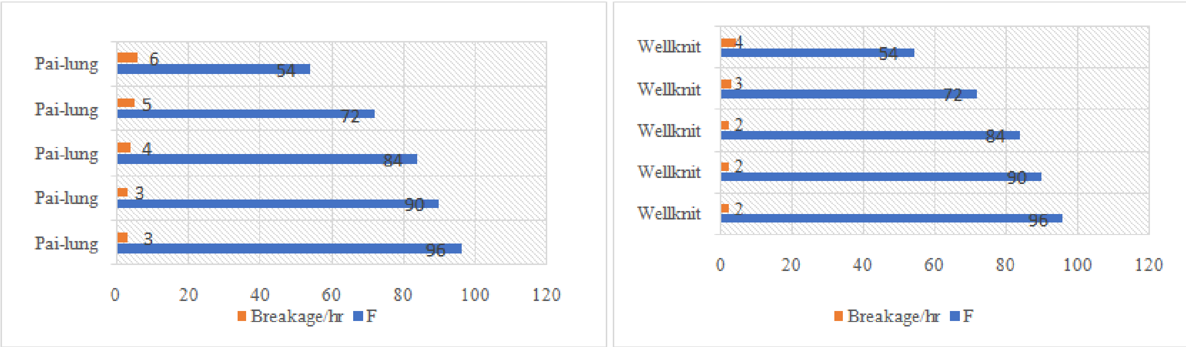

Figure4: Feeder vs Yarn Breakage

Theory explains that with increasing in machine RPM and number of feeders can lead to a higher rate of production provided efficiency remains same. The Large number of feeders also gives rise to what is known as drop or skewness (https://nptel.ac.in/). Figure 4 shows that using up to a certain number of feeders remains low breakage that improves production rate and efficiency of the machine.

3.5 The relationship between breakage rate and yarn count has been tabulated in Table 5 and graphically shown in Figure 5.

Table 5: Diameter vs. Hourly Production

No	*Brand*	*Dia*	*G*	*N*	*F*	*SL*	*Ne*	*η*	*Breakage/hr*	*RPM*	*Prodn in kg/hr*
1	Pai-lung	32	24	2400	96	2.66	30	0.85	3	34	20.86
	Wellknit							0.9	2	24	15.59
2	Pai-lung	30		2256	90			0.85	3	36	19.46
	Wellknit							0.9	2	25	14.31
3	Pai-lung	28		2088	84			0.8	4	40	17.58
	Wellknit							0.9	2	27	13.35
4	Pai-lung	24		1800	72			0.75	5	46	14.00
	Wellknit							0.85	3	34	11.73
5	Pai-lung	18		1344	54			0.7	6	54	8.59
	Wellknit							0.8	4	40	7.27

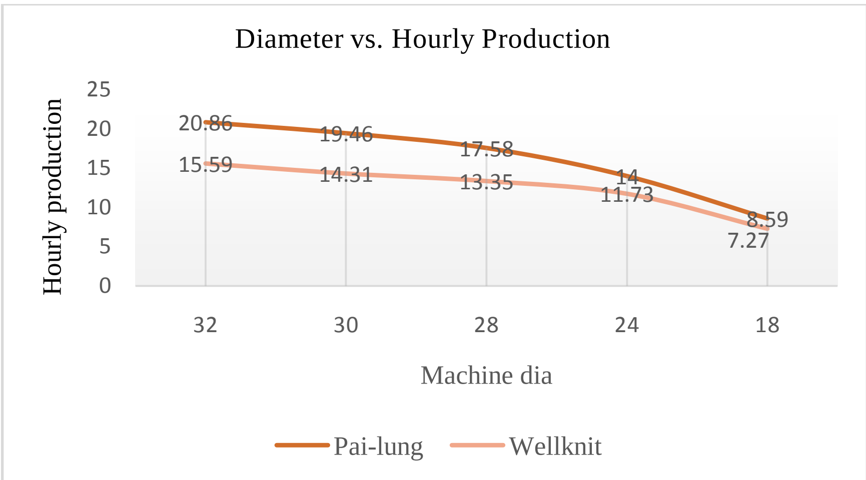

Figure 2: Diameter vs. Hourly Production

Line graph 5 shows, the production rates are gradually decreasing with decreasing machine diameter for both type of machines. If machine gauge remains constant then total number of needles in cylinder circumference will be more for increased diameter. So the numbers of loops in a single course will be increased and also decreased stitch length for the lower diameter machine as well. As a result, production will improve (Kg) for high gram per sq. meter fabric. Illustrated that, here the figure is not showing a comparison between the machine brand.

3.6 The relationship between breakage rate and yarn count has been tabulated in Table 6 and graphically shown in Figure 6.

Table 6 :RPM vs. Hourly Production

No	*Brand*	*Dia*	*G*	*N*	*F*	*SL*	*Ne*	*η*	*Breakage/hr*	*RPM*	*Prod^n in kg/hr*
1								0.9	2	25	16.24
2								0.9	3	32	19.63
3	Pai-lung	32	24	2400	96	2.66	30	0.8	4	45	25.98
4								0.7	6	50	25.26
5								0.6	8	55	23.81

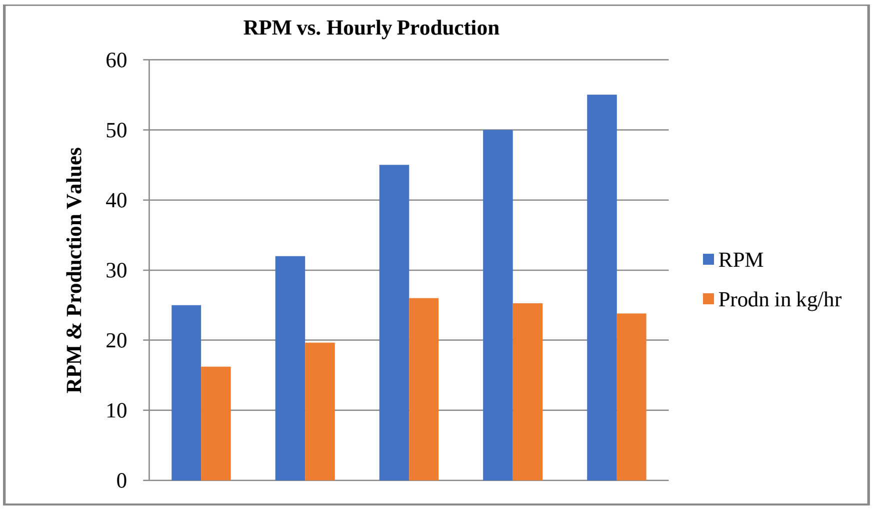

Figure 3:RPM vs. Hourly Production

From the bar chart 6 it can be concluded, the relation between production and RPM is very much linear according to literature. This is, because of the production of courses per unit time is higher when other variables remain constant. Machine RMP increases the production up to a certain limit, after passing it tends to decrease.

3.7 The relationship between breakage rate and yarn count has been tabulated in Table 7 and calculation demonstrated in below:

Table 7*:* Production Cost vs. Power Consumption

Description	*P / Capacity/day(30 Ne)*	*Speed (RPM)*	*PWR Consumption (KW)*
16” x 24G x 48F	220~260Kg	42~46	88
17” x 24G x 51F	230~270Kg	41~45	88
18” x 24G x 54F	240~280Kg	40~44	88
19” x 24G x 57F	250~290Kg	39~43	88
20” x 24G x 60F	260~300Kg	38~42	88
21” x 24G x 63F	270~310Kg	37~41	88
22” x 24G x 66F	280~320Kg	36~40	88
23” x 24G x 69F	290~330Kg	35~39	88
24” x 24G x 72F	300~340Kg	34~38	88
25” x 24G x 75F	310~350Kg	33~37	88
26” x 24G x 78F	320~360Kg	32~36	88
28” x 24G x 84F	330~370Kg	31~35	88
30” x 24G x 96F	340~380Kg	30~34	88
32” x 24G x 102F	350~390Kg	29~33	132
34” x 24G x 108F	360~400Kg	28~32	132
36” x 24G x 116F	370~410Kg	27~30	132
38” x 24G x 122F	380~420Kg	26~29	132
40” x 24G x 128F	390~430Kg	25~28	132

From the above table, the power consumption of 16-inch to 30-inch dia machine is same (88 KW per day), but production is not, due to the number of feeders. Since the target of any industry is quality production. So, the table suggests industrialist for choosing higher diametric machines. Because it is transparent to all that, higher diametric machine contains more feeders and hence production will be higher.

It can be shown by simple calculations-

Say, Power consumption of 30-inch diameter machine= 88KW/24hrs= 88 B.O.T unit/ 24hrs

If 1-unit electricity charge is 7 taka and knitting charge is 12 taka/kg (industry practice)

Then, Total cost= (7×88) = 616 taka/24hrs

Production of (30" x 24G x 96F) machine=350 kg/ 24hrs at 32 rpm

Total charge in 24 hrs.= 350×12=4200 taka
Now we know from this 4200-taka, 616 taka spends on power.
If we use (24" x 24G x 72F) machine then power consumption will be same.
But production= 310 kg/24 hrs. at 32 rpm
Total charge in 24 hrs.= 310×12=3720 taka
From this 3720-taka, 616 taka spends on power.
Rest of money includes machine cost, parts cost, maintenance cost and labor cost.
So, when we buy knitting machine, it must be checked on power and production ability per hour.

IV. Conclusions

In this study, the effects of yarn count, type of yarn, machine rpm and number of feeders into yarn breakage were investigated. Besides the effects of machine diameter and machine rpm into production rate also analyzed. Moreover, the power consumption with respect to machine diameter and total production was calculated. Finally the following expressions were found:

1. RPM $\propto \frac{1}{d}$ (for constant knitting speed)
2. Fabric in kg/hrs. $\propto$ RPM
3. Breakage rate $\propto$ RPM
4. Tension on yarn $\propto$ RPM
5. RPM $\propto \frac{1}{Ne}$
6. Breakage rate $\propto$ count (Ne)
7. Breakage rate of carded yarn $>$ breakage rate of combed yarn
8. Loss in knitting section due to yarn breakage
9. Cost of power consumption by machine
10. Efficiency $\propto \frac{1}{Breakage\ \ rate}$

Acknowledgement

Authors are expressing their heartfelt gratitude to **Blue planet Knitwear Industry, Mawna, Gazipur, Bangladesh** for immense support to conduct the research**.**

References

[1]. Catarino, A. et al. (2004) 'A new system for monitoring and analysis of the knitting process', pp. 415–420. doi: 10.1109/icmech.2004.1364475.
[2]. Das, A. and Ishtiaque, S. M. (2004) 'End breakage in rotor spinning: Effect of different variables on cotton yarn end breakage', Autex Research Journal, 4(2), pp. 52–59.
[3]. Duru, S. C., Candan, C. and Mugan, A. (2015) 'Effect of yarn, machine and knitting process parameters on the dynamics of the circular knitting needle', Textile Research Journal, 85(6), pp. 568–589. doi: 10.1177/0040517514547216.
[4]. Ghosh, S. and Banerjee, P. K. (1990) 'Mechanics of the Single Jersey Weft Knitting Process', Textile Research Journal, 60(4), pp. 203–211. doi: 10.1177/004051759006000403.
[5]. Knapton, J. J. F. and Munden, D. L. (2007) 'A Study of the Mechanism of Loop Formation on Weft-Knitting Machinery', Textile Research Journal, 36(12), pp. 1072–1080. doi: 10.1177/004051756603601207.
[6]. Lek-uthai, J. (1999) 'Circular in Knitting Quality Assurance Part I : Theoretical Analvsis', 4(l), pp. 72–81.
[7]. Management, P. and Science, C. (2009) 'Backward Linkages in Readymade Garment Industry of Bangladesh: Appraisal and Policy Implications', 6(2), pp. 1–11.
[8]. Peterson, J. and Ekwall, D. (2007) 'Production and business methods in the integral knitting supply chain', Autex Research Journal, 7(4), pp. 264–274.
[9]. Reza, M. H. (2015) 'a Study on Causes of Knitting Machine Stoppages and Their Impact on Fabric', 11(33), pp. 262–269.
[10]. Siddika, A. et al. (2017) 'Effects of Carded and Combed Yarn on Pilling and Abrasion Resistance of Single Jersey Knit Fabric', IOSR Journal of Polymer and Textile Engineering, 04(02), pp. 39–43. doi: 10.9790/019x-04023943.
[11]. Solaiman, M. et al. (2014) 'Efficiency Losses Calculation and Identify Causes of Losses of Circular Knitting Machine during Knit Fabric Production', Manufacturing Science and Technology. doi: 10.13189/mst.2014.020501.
[12]. Warping breakage control for quality sized beam and increasing weaving efficiency (March 7, 2018), retrieved from: https://www.textiletoday.com.bd
[13]. https://nptel.ac.in/courses/116102008/12

Taslima Ahmed Tamanna. "Evaluating the Co-relation among the Parameters of Circular Weft-Knitting Machine." IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE) , vol. 6, no. 6, 2019, pp. 07-13