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Comparative Study on Different Fabric Consumption Methods of Different Garments

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KEYWORDS

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Marker Making
Consumption
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ABSTRACT

Contemporary garment enterprises must exhibit remarkable adaptability to create diverse styles and types of clothing in response to market demands for their survival. Enhanced excellence across all dimensions justifies optimum pricing. In competitive marketplace, cost calculation of garment not only optimum for net profit generation but also necessary to avoid order rejection. During the initial stages of order acquisition, fabric consumption estimates must be established using mathematical approximations before actual marker creation. Among the two commonly employed mathematical methods for fabric consumption, the alignment of specific formulas with particular garment types has not been thoroughly analyzed. The aim of this study is to identify the most accurate method of fabric consumption for various garment categories. For this purpose, six distinct garments have been selected for experimentation: two woven shirts (short and long sleeves) and four knit T-shirts (including two set-in sleeve variations with long and short sleeves, and two raglan sleeve variations with long and short sleeves). Pattern making and grading were executed using specification sheet measurements, followed by marker creation utilizing Boke CAD software. Subsequently, fabric consumption for all six garments has been compared using 3 fabric consumption methods: one marker planning method and two mathematical methods. Although the marker planning method is well-established as the most accurate means of fabric consumption determination, its usage requires pattern and marker preparation prior to production. This limitation necessitates the use of mathematical formulas during preliminary stages for cost calculations and order processing. Comparative analysis highlights that neither mathematical formula is universally suitable for all garment types, suggesting that specific formulas should be applied to distinct garments. As such, this guideline serves as a valuable industry resource, preventing unnecessary fabric wastage caused by misusing mathematical formulas and thereby contributing to sustainability efforts.

1. INTRODUCTION

Over the past three decades, sustainability has emerged as a pivotal concern for corporations, driven by the finite global resources and heightened societal awareness [1-3]. With the world's population expanding and concurrently experiencing improved life expectancy, enhanced quality of life, and increased affluence, resource scarcity intensifies due to the escalating demands to meet the needs and desires of this burgeoning population [4]. Resource depletion has thus become a central facet of sustainability discourse. Sustainable development endeavors to ensure efficient resource utilization to meet present needs while safeguarding resources for future generations. Within the UN Sustainable Development Goals (SDGs) for 2030 [5], goal number 12 concentrates on establishing sustainable consumption and production patterns. Key targets within this goal encompass achieving sustainable resource management, substantial waste reduction, and bolstering scientific and technological capacities for more sustainable production-consumption paradigms. Furthermore, goal number 8 [5] underscores the progressive improvement of resource efficiency in consumption and production. According to a report by Lenzing AG [6], the global consumption of apparel fibers reached approximately 106 million tons in 2018, with 70-75% being allocated to the apparel sector. The apparel industry consumes significant natural resources to yield 1 kg of fabric, necessitating around 350-1500 grams of chemicals and 700 liters of water for finishing processes alone [7]. The resource depletion caused by fabrics in the garment industry can be minimized by efficient use of fabric by increasing marker efficiency, proper selection of fabric width and proper fabric consumption calculation, contributing to a more sustainable production environment. If the fabric consumption is more, the cost will be more and hence it will not only lead to order rejection in competitive marketplace but also leads to dead-stock or leftovers even if the order is not rejected. Excessive fabric consumption not only escalates costs but also risks order rejection in a fiercely competitive market, leading to the accumulation of dead-stock or surplus even in the absence of order rejection [8]. This issue extends to the considerable annual accumulation of dead stock or remnants [9]. Enhancements in marker efficiency, width utilization, and end-loss reduction can be rendered futile if over-purchasing persists, perpetuating dead-stock. Mitigating this challenge requires a shift away from error-protective purchasing habits towards precision-driven buying [10]. While efficiency improvements within the cutting room are worthless, they may lose value if excess fabric has already been procured. Consequently, extensive research is being conducted within the textile and garment production sector to mitigate fabric waste and bolster sustainability efforts.

In the present day, garment manufacturers must vigilantly manage their expenditures to ensure their survival and sustained achievements within a fiercely competitive market. Fabric, a pivotal constituent of the clothing sector, typically comprises around 60% of the total garment cost [11]. The computation of fabric costs is intrinsically linked to fabric consumption, where escalated consumption drives elevated expenses. Hence, optimizing material utilization stands as a cornerstone strategy for cost reduction and enhancing product competitiveness [12]. The reduction of fabric wastage holds significant implications for minimizing the overall garment production expenditure [13]. Consequently, an accurate calculation of fabric consumption and associated costs holds significant importance. Two primary approaches exist for fabric consumption calculation: marker planning and mathematical methods. Two primary approaches exist for fabric consumption calculation: marker planning and mathematical methods. The first involves utilizing a single formula, focusing on the maximum dimensions of larger pattern pieces while omitting smaller components, assuming these smaller pieces will fit within gaps between the larger ones. In contrast, the second mathematical approach incorporates the maximum dimensions of both small and large pattern components. In the preliminary stages of garment order formulation, when merchants calculate consumption and costs for negotiation, they frequently opt for a particular mathematical method of fabric consumption. But which method is suitable for which type of product is not been analyzed by any researcher. Thus, conducting a comparative study to determine the most suitable mathematical consumption method based on the nature of the product emerges as a crucial undertaking.

2. MATERIALS AND METHODS

For this experiment, six garments two woven shirts (short & long sleeve) and four knit T-shirts (Two set in sleeves having long & short sleeve and two raglan sleeves having long & short sleeve) have been selected. Then pattern making and grading have been done using measurements of the specification sheets. After that, markers have been created using Boke CAD software. Finally, all six garments' consumption have been calculated and compared using 3 different consumption formulas: one marker planning & two mathematical methods.

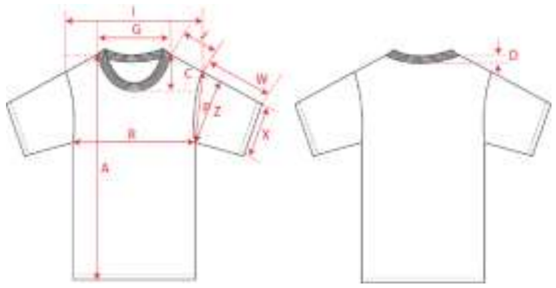

Figure 1: Knit Spec 1 - Short set-in sleeve men's T-shirt

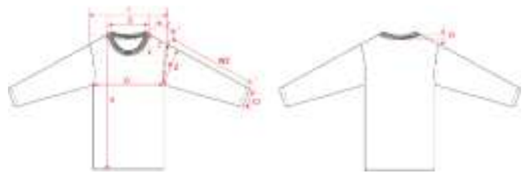

Figure 2: Knit Spec 2 - Long set-in sleeve men's T-shirt

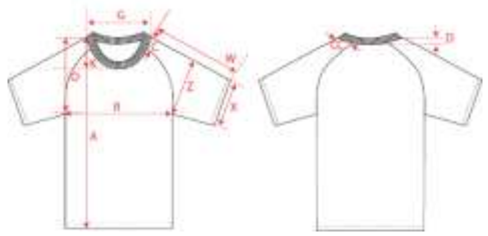

Figure 3: Knit Spec 3 - Short Raglan sleeve men's T-shirt

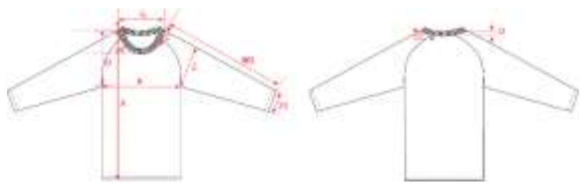

Figure 4: Knit Spec 4 - Long Raglan sleeve men's T-shirt

Table 1: Combined measurements of all four spec sheets

For Spec	POM	Measurement Name	S	M	L*	XL	XXL
Knit Spec 1, 2, 3 & 4	R	Half Chest	48	51	54	57	60
	A	High Point Shoulder	70	72	74	76	78
	G	Neck Width	16	17	18	19	20
	D	Back Neck drop	1.5	1.5	1.5	1.5	1.5
	C	Front Neck Drop	8	8.5	9	9.5	9.5
Knit Spec 1 & 2	P	Arm Hole Straight	24	25	26	27	28
	I	Across Shoulder	45	48	51	54	57
	J	Shoulder length	15	16	17	18	19
Knit Spec 1 & 3	Z	Short Sleeve Width	23	23.75	24.5	25.25	26
	X	Short Sleeve Opening	18	19	20	21	22
Knit Spec 2 & 4	W2	Long Sleeve Width	22.5	23.25	24	24.75	25.5
	X2	Long Sleeve Opening	15	15.5	16	16.5	17
Knit Spec 3 & 4	O	Armscye Depth	26	27	28	29	30
	C	Forward shoulder front	6	6	6	6	6
	CC	Forward shoulder back	4	4	4	4	4
Knit Spec 1	W	Short Sleeve Length	21	22	23	24	25
Knit Spec 2	W2	Long Sleeve Length	55	56	57	58	59
Knit Spec 3	W	Short Sleeve Length from neck	36	38	40	42	44
Knit Spec 4	W2	Long Sleeve Length from neck	70	72	74	76	78

2.1 CONSUMPTION OF SHORT SET-IN SLEEVE T-SHIRT BY SINGLE FORMULA:

Figure 5: Short Set-in Sleeve T-shirt pattern with sewing allowance by Boke CAD

$$= \frac{(BL + SL + All) \times (HC + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(74 + 23 + 8) \times (54 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{105 \times 56 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

= 2.48 Kg/Doz

2.2 CONSUMPTION OF SHORT SET-IN SLEEVE T-SHIRT BY INDIVIDUAL FORMULA:

2.2.1 BODY PART CONSUMPTION

$$= \frac{(BL + All) \times (HC + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(74 + 4) \times (54 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{78 \times 56 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

=1.85 Kg/Doz

2.2.2 SLEEVE CONSUMPTION

$$= \frac{(SL + All) \times (SW \times 2 + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(23 + 4) \times (49 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{27 \times 51 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

= 0.58 Kg/Doz

2.2.3 TOTAL CONSUMPTION BY INDIVIDUAL FORMULA FOR SHORT SET-IN SLEEVE T-SHIRT

= (1.85+0.58) Kg/Doz = 2.43 Kg/Doz

2.3 CONSUMPTION OF SHORT SET-IN SLEEVE T-SHIRT BY MARKER PLANNING METHOD:

Figure 6: Short Set-in Sleeve T-shirt marker by Boke CAD

$$= \frac{Marker\ Width(cm) \times (Marker\ Length(cm) + All) \times 12 \times 1.10 \times 160}{10000000 \times 5}$$

$$= \frac{168 \times (346.53 + 5) \times 12 \times 1.10 \times 160}{10000000 \times 5}$$

$$= \frac{168 \times 351.53 \times 12 \times 1.10 \times 160}{10000000 \times 5} \text{ Kg/Doz}$$

= 2.49 Kg/Doz

2.4 CONSUMPTION OF LONG SET-IN SLEEVE T-SHIRT BY SINGLE FORMULA:

Figure 7: Long Set-in Sleeve T-shirt pattern with sewing allowance by Boke CAD

$$= \frac{(BL + SL + All) \times (HC + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(74 + 57 + 8) \times (54 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{139 \times 56 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

= 3.29 Kg/Doz

2.5 CONSUMPTION OF LONG SET-IN SLEEVE T-SHIRT BY INDIVIDUAL FORMULA:

2.5.1 BODY PART CONSUMPTION

$$= \frac{(BL + All) \times (HC + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(74 + 4) \times (54 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{78 \times 56 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

=1.85 Kg/Doz

2.5.2 SLEEVE CONSUMPTION

$$= \frac{(SL + All) \times (SW \times 2 + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(57 + 4) \times (49 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{61 \times 51 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

= 1.31 Kg/Doz

2.5.3 Total Consumption by individual formula for Long Set-in Sleeve T-shirt

= (1.85+1.31) Kg/Doz = 3.16 Kg/Doz

2.6 Consumption of long set-in sleeve T-shirt by marker planning method:

Figure 8: Long Set-in Sleeve T-shirt marker by Boke CAD

$$= \frac{Marker\ Width(cm) \times (Marker\ Length(cm) + All) \times 12 \times 1.10 \times 160}{10000000 \times 5}$$

$$= \frac{168 \times (454.46 + 5) \times 12 \times 1.10 \times 160}{10000000 \times 5}$$

$$= \frac{168 \times 459.46 \times 12 \times 1.10 \times 160}{10000000 \times 5} \text{ Kg/Doz}$$

= 3.26 Kg/Doz

2.7 CONSUMPTION OF SHORT RAGLAN SLEEVE T-SHIRT BY SINGLE FORMULA:

Figure 9: Short Raglan Sleeve T-shirt pattern with sewing allowance by Boke CAD

$$=\frac{(BL+SL+All)\times(HC+All)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{(74+23+8)\times(54+2)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{105\times 56\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}\text{ Kg/Doz}$$

=2.48 Kg/Doz

2.8 CONSUMPTION OF SHORT RAGLAN SLEEVE T-SHIRT BY INDIVIDUAL FORMULA:

2.8.1 BODY PART CONSUMPTION

$$=\frac{(BL+All)\times(HC+All)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{(74+4)\times(54+2)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{78\times 56\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}\text{ Kg/Doz}$$

=1.85 Kg/Doz

2.8.2 Sleeve consumption

$$=\frac{(SL+All)\times(SW\times 2+All)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{(43.45+4)\times(49+2)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{47.45\times 51\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}\text{ Kg/Doz}$$

=1.02 Kg/Doz

2.8.3 TOTAL CONSUMPTION BY INDIVIDUAL FORMULA FOR SHORT RAGLAN SLEEVE T-SHIRT

= (1.85+1.02) Kg/Doz = 2.87 Kg/Doz

2.9 CONSUMPTION OF SHORT RAGLAN SLEEVE T-SHIRT BY MARKER PLANNING METHOD:

Figure 10: Short Raglan Sleeve T-shirt marker by Boke CAD

$$=\frac{Marker\ Width(cm)\times(Marker\ Length(cm)+All)\times 12\times 1.10\times 160}{10000000\times 5}$$

$$=\frac{168\times(389.48+5)\times 12\times 1.10\times 160}{10000000\times 5}$$

$$=\frac{168\times 394.48\times 12\times 1.10\times 160}{10000000\times 5}\text{ Kg/Doz}$$

= 2.80 Kg/Doz

2.10 CONSUMPTION OF LONG RAGLAN SLEEVE T-SHIRT BY SINGLE FORMULA:

Figure 11: Long Raglan Sleeve T-shirt pattern with sewing allowance by Boke CAD

$$=\frac{(BL+SL+All)\times(HC+All)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{(74+57+8)\times(54+2)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{139\times 56\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}\text{ Kg/Doz}$$

= 3.29 Kg/Doz

2.11 CONSUMPTION OF LONG RAGLAN SLEEVE T-SHIRT BY INDIVIDUAL FORMULA:

2.11.1 BODY PART CONSUMPTION

$$=\frac{(BL+All)\times(HC+All)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$=\frac{(74+4)\times(54+2)\times 2\times 12\times 1.10\times 160}{100\times 100\times 1000}$$

$$= \frac{78 \times 56 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

=1.85 Kg/Doz

2.11.2 SLEEVE CONSUMPTION

$$= \frac{(SL + All) \times (SW \times 2 + All) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{(77.39 + 4) \times (49 + 2) \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000}$$

$$= \frac{81.39 \times 51 \times 2 \times 12 \times 1.10 \times 160}{100 \times 100 \times 1000} \text{ Kg/Doz}$$

= 175 Kg/Doz

2.11.3 TOTAL CONSUMPTION BY INDIVIDUAL FORMULA FOR LONG SET-IN SLEEVE T-SHIRT

= (1.85+1.75) Kg/Doz = 3.6 Kg/Doz

2.12 CONSUMPTION OF LONG RAGLAN SLEEVE T-SHIRT BY MARKER PLANNING METHOD:

Figure 12: Long Raglan Sleeve T-shirt marker by Boke CAD

$$= \frac{Marker\ Width(cm) \times (Marker\ Length(cm) + All) \times 12 \times 1.10 \times 160}{10000000 \times 5}$$

$$= \frac{168 \times (498.23 + 5) \times 12 \times 1.10 \times 160}{10000000 \times 5}$$

$$= \frac{168 \times 503.23 \times 12 \times 1.10 \times 160}{10000000 \times 5} \text{ Kg/Doz}$$

= 3.57 Kg/Doz

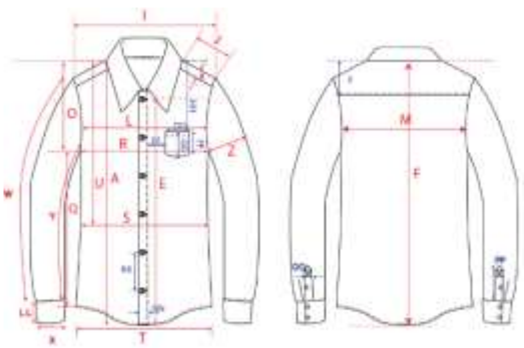

Figure 13: Woven Spec 1 - Long Sleeve Basic Shirt

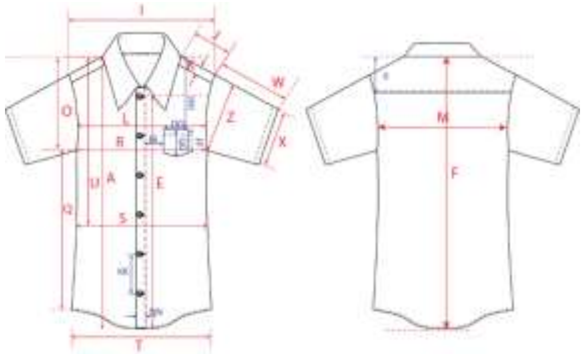

Figure 14: Woven Spec 2 - Short Sleeve Basic Shirt

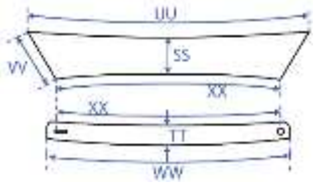

Figure 15: Collar for both Long & Short Sleeve Shirt

Table 2: Combined measurements for Both Short & Long Sleeve Shirt

For Spec	POM	Description	S	M	L*	XL	XXL
For Both Long & Short Sleeve Shirt	A	High Point Shoulder	74.4	77.4	79.4	81.4	83.4
	R	Half chest	53.00	55.60	58.00	61.50	65.00
	S	Half Waist	51.00	53.50	56.00	59.50	63.00
	T	Bottom width	52.00	54.50	57.00	60.50	64.00
	I	Across Shoulder	47.00	47.90	48.80	50.10	51.40
	J	Shoulder Length	15.80	16.00	16.20	16.50	16.80
	L	Across front	42.00	43.30	44.60	46.40	48.20
	M	Across back	44.20	45.50	46.80	48.60	50.40
	E	Center front length without collar	66.90	68.70	70.50	72.30	74.10
	F	Center back length without collar	74.00	76.00	78.00	80.00	82.00
	Q	Side seam length	41.40	42.90	44.40	45.90	47.40
	U	Natural Waist Length	46.4	47.2	48	49.2	50.4
	O	Armscye Depth	28.00	28.50	29.00	29.70	30.40
	Z	Sleeve Width	19.90	20.70	21.50	22.60	23.70
	GG	Pocket height (center)	13.50	13.50	13.50	13.50	13.50
	DD	Pocket width	11.50	11.50	11.50	11.50	11.50
	HH	Position of pocket from CF neckline	20.60	20.80	21.00	21.20	21.40
	EE	Position of pocket from placket	4.10	4.30	4.50	4.70	4.90
	NN	Placket width	2.70	2.70	2.70	2.70	2.70
	KK	Distance between buttons	9.00	9.00	9.00	9.00	9.00
	TT	Centre back stand collar height	3.60	3.60	3.60	3.60	3.60
	UU	Collar circumference	43.00	44.00	45.00	46.50	48.00
	VV	Collar point	7.00	7.00	7.00	7.00	7.00
	WW	Collar circumference (across neck seam)	45.40	46.40	47.40	48.90	50.40

	XX	Collar size	41.00	42.00	43.00	44.50	46.00
	II	Yoke height side	10.60	10.80	11.00	11.20	11.40
	FF	Pocket height (side)	11.00	11.00	11.00	11.00	11.00
	K	Forward Shoulder	3.00	3.00	3.00	3.00	3.00
Only for Long Sleeve Shirt	W	Long Sleeve length	57	58.5	60	61.5	63
	Y	Long Under Sleeve	43.4	44.7	46	47.2	48.4
	LL	Cuff height	6.00	6.00	6.00	6.00	6.00
	PP	Sleeve's placket height	15.00	15.00	15.00	15.00	15.00
	OO	Sleeve's placket width	2.50	2.50	2.50	2.50	2.50
	X	Cuff width (Sleeve opening)	11.40	11.60	11.80	12.00	12.20
Only for Short Sleeve Shirt	W	Short Sleeve length	26	27.5	29	30.5	32
	X	Short Sleeve opening	11.40	11.60	11.80	12.00	12.20

2.13 CONSUMPTION OF LONG SLEEVE SHIRT BY SINGLE FORMULA:

Figure 16: Long sleeve shirt patterns including sewing allowance

$$=\frac{(BL+SL+All)\times(HC+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(79.4+60+4)\times(58+10.8)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{143.4\times 68.8\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 20.39 Yds/Doz

2.14 CONSUMPTION OF LONG SLEEVE SHIRT BY INDIVIDUAL FORMULA:

2.14.1 FRONT BODY RIGHT PART CONSUMPTION

$$=\frac{(BL+All)\times(\frac{HC}{2}+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(76.44+2)\times(29+5.25)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{78.44\times 34.25\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

=2.86 Yds/Doz

2.14.2 FRONT BODY LEFT PART CONSUMPTION

$$=\frac{(BL+All)\times(\frac{HC}{2}+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(76.44+2)\times(29+5.55)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{78.44\times 34.55\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

=2.88 Yds/Doz

2.14.3 BACK BODY PART CONSUMPTION

$$=\frac{(BL+All)\times(HC+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(68.4+2)\times(58+2)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{70.4\times 60\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

=4.36 Yds/Doz

2.14.4 SLEEVE CONSUMPTION

$$=\frac{(SL+All)\times(SW\times 2+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(60+2)\times(43+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{62\times 45\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 5.77 Yds/Doz

2.14.5 YOKE CONSUMPTION

$$=\frac{(YH+All)\times(YW+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(13.9+2)\times(50.45+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{15.9\times 52.45\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 1.72 Yds/Doz

2.14.6 CUFF CONSUMPTION

$$=\frac{(CH+All)\times(CW\times 2+All)\times 4\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(6+2)\times(13.3\times 2+2)\times 4\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{8\times 28.6\times 4\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\ \text{Yds/Doz}$$

= 0.95 Yds/Doz

2.14.7 COLLAR CONSUMPTION

$$= \frac{(CoH + All)\times (CoW + All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{(6.94+2)\times (44.77+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{8.94\times 46.77\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\ \text{Yds/Doz}$$

= 0.86 Yds/Doz

2.14.8 COLLAR BAND CONSUMPTION

$$= \frac{(CoBH + All)\times (CoBW + All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{(4.1+2)\times (47.38+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{6.1\times 49.38\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\ \text{Yds/Doz}$$

= 0.62 Yds/Doz

2.14.9 UPPER SLEEVE PLACKET CONSUMPTION

$$= \frac{(USPH + All)\times (USPW\times 2 + All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{(15+2)\times (2.5\times 2+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{17\times 7\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\ \text{Yds/Doz}$$

= 0.25 Yds/Doz

2.14.10 LOWER SLEEVE PLACKET CONSUMPTION

$$= \frac{(LSPH + All)\times (LSPW\times 2 + All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{(12+2)\times (1\times 2+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{14\times 4\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\ \text{Yds/Doz}$$

= 0.12 Yds/Doz

2.14.11 POCKET CONSUMPTION

$$= \frac{(PH + All)\times (PW + All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{(11.5+4)\times (13.5+2)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$= \frac{15.5\times 15.5\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\ \text{Yds/Doz}$$

= 0.25 Yds/Doz

2.14.12 TOTAL CONSUMPTION BY INDIVIDUAL FORMULA METHOD FOR LONG SLEEVE SHIRT

= (Front Body Right part consumption + Front Body Left part consumption + Back Body part consumption + Sleeve consumption + Yoke Consumption + Cuff consumption + Collar consumption + Collar Band consumption + Upper Sleeve Placket consumption + Lower Sleeve Placket consumption + Pocket Consumption)
= (2.86 + 2.88 + 4.36 + 5.77 + 1.72 + 0.95 + 0.86 + 0.62 + 0.25 + 0.12 + 0.25) Yds/Doz
= 20.64 Yds/Doz

2.15 CONSUMPTION OF LONG SLEEVE SHIRT BY MARKER PLANNING METHOD:

Figure 17: Long sleeve shirt Marker

$$= \frac{\text{Marker Length (Inch)} + All\times 12\times 1.10}{36\times \text{Number of Garments in the Marker}}$$

$$= \frac{264.34''+2''\times 12\times 1.10}{36\times 5}$$

$$= \frac{266.34''\times 12\times 1.10}{36\times 5}\ \text{Yds/Doz}$$

= 19.53 Yds/Doz

2.16 Consumption of short sleeve shirt by single formula:

Figure 18: Short sleeve basic shirt patterns including sewing allowance

$$=\frac{(BL+SL+All)\times(HC+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(79.4+29+6)\times(58+10.8)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{114.4\times 68.8\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 16.27 Yds/Doz

2.17 CONSUMPTION OF SHORT SLEEVE SHIRT BY INDIVIDUAL FORMULA:

2.17.1 FRONT BODY RIGHT PART CONSUMPTION

$$=\frac{(BL+All)\times(\frac{HC}{2}+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(76.44+2)\times(29+5.25)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{78.44\times 34.25\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

=2.86 Yds/Doz

2.17.2 FRONT BODY LEFT PART CONSUMPTION

$$=\frac{(BL+All)\times(\frac{HC}{2}+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(76.44+2)\times(29+5.55)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{78.44\times 34.55\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

=2.88 Yds/Doz

2.17.3 BACK BODY PART CONSUMPTION

$$=\frac{(BL+All)\times(HC+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(68.4+2)\times(58+2)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{70.4\times 60\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

=4.36 Yds/Doz

2.17.4 SLEEVE CONSUMPTION

$$=\frac{(SL+All)\times(SW\times 2+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(29+4)\times(43+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{33\times 45\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 3.07 Yds/Doz

2.17.5 YOKE CONSUMPTION

$$=\frac{(YH+All)\times(YW+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(13.9+2)\times(50.45+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{15.9\times 52.45\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 1.72 Yds/Doz

2.17.6 COLLAR CONSUMPTION

$$=\frac{(CoH+All)\times(CoW+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(6.94+2)\times(44.77+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{8.94\times 46.77\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 0.86 Yds/Doz

2.17.7 COLLAR BAND CONSUMPTION

$$=\frac{(CoBH+All)\times(CoBW+All)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(4.1+2)\times(47.38+2)\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{6.1\times 49.38\times 2\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 0.62 Yds/Doz

2.17.8 POCKET CONSUMPTION

$$=\frac{(PH+All)\times(PW+All)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{(11.5+4)\times(13.5+2)\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}$$

$$=\frac{15.5\times 15.5\times 12\times 1.10}{36\times 55''\times 2.54\times 2.54}\text{ Yds/Doz}$$

= 0.25 Yds/Doz

2.17.9 TOTAL CONSUMPTION BY INDIVIDUAL FORMULA METHOD FOR LONG SLEEVE SHIRT

= (Front Body Right part consumption + Front Body Left part consumption + Back Body part consumption + Sleeve consumption + Yoke Consumption + Collar consumption + Collar Band consumption + Pocket Consumption)

= (2.86 + 2.88 + 4.36 + 3.07 + 1.72 + 0.86 + 0.62 + 0.25) Yds/Doz

= 16.62 Yds/Doz

2.18 CONSUMPTION OF LONG SLEEVE SHIRT BY MARKER PLANNING METHOD:

Figure 19: Short sleeve basic shirt marker

$$= \frac{\text{Marker Length (Inch)} + All \times 12 \times 1.10}{36 \times \text{Number of Garments in the Marker}}$$

$$= \frac{224.26'' + 2'' \times 12 \times 1.10}{36 \times 5}$$

$$= \frac{226.26'' \times 12 \times 1.10}{36 \times 5} \text{ Yds/Doz}$$

= 16.59 Yds/Doz

3. RESULTS AND DISCUSSION

3.1 RESULT

Comparative result of different consumption methods of different garments are shown below:

Table 3: Comparison of Fabric Consumption Methods (Woven)

Product	Consumption per doz (Yds)		
	Consumption Methods		
	Single Formula	Individual Formula	Marker planning Method
Shirt Long Sleeve	20.39	20.64	19.53
Shirt Short Sleeve	16.27	16.62	16.39

Figure 20: Column chart on Comparison of Fabric Consumption Methods (Woven)

Table 4: Comparison of Fabric Consumption Methods (Knit)

Product	Consumption per doz (Kg)		
	Consumption Methods		
	Single Formula	Individual Formula	Marker planning Method
Short Set-in sleeve T-shirt	2.48	2.43	2.49
Long Set-in sleeve T-shirt	3.29	3.16	3.26
Short Raglan sleeve T-shirt	2.48	2.87	2.8
Long Raglan sleeve T-shirt	3.29	3.6	3.57

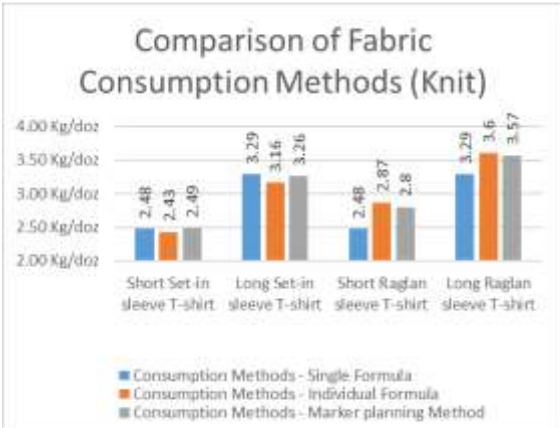

Figure 21: Column chart on Comparison of Fabric Consumption Methods (Knit)

3.2 RESULT DISCUSSION

From the table 3 & 4 and figure 20 & 21, it can be said that single formula method of woven long sleeve shirt consumption is close to marker planning method due to the presence of smaller components or patterns which are placed in the gap among the larger pieces. Whereas individual formula (maximum dimension) method result of woven short sleeve shirt consumption is close to marker planning method because it doesn't contain too much smaller components or patterns. Again, for single formula result of knit short & long sleeve t-shirt consumption is close to marker planning method because it doesn't contain any smaller components or patterns. In case of raglan sleeve consumption for both short & long, the individual formula (maximum dimension) method match with the marker planning method. So, it can be said that marker planning method is the best of all three methods because the final production is depending on it. But before actual production when merchandisers have to make consumption from spec sheet they should use single formula method for long sleeve woven shirt, short sleeve & long sleeve knit T-shirt only. In case of raglan sleeve for both short & long sleeve they should use individual formula (maximum dimension) method of consumption.

4. CONCLUSION

In the context of the garment industry, the equilibrium between profitability and losses pivots predominantly on the precise assessment of fabric utilization per order. Thus, it is imperative to meticulously compute fabric requirements before embarking on the cutting phase. Two primary methodologies hold prominence in calculating fabric consumption within the garment industry: the mathematical approach and the marker making approach. The mathematical approach typically involves the application of specific formulas to determine the fabric needed for a given garment. Conversely, marker making consumption is facilitated through CAD software. The financial allocation for fabric in a product is intrinsically entwined with the quantity of fabric employed, encompassing both usable material and waste. Consequently, precise fabric consumption calculation stands as a pivotal determinant of profitability. This research serves not only to enhance computation precision but also to serve as a guiding reference for improved calculations and future endeavors. Efforts to minimize fabric usage per garment, coupled with waste reduction during cutting operations, yield benefits for economic and environmental sustainability. Strategically enhancing fabric utilization, both in the immediate and extended duration, yields favorable outcomes for both the economy and the environment. Furthermore, the prudent use of materials serves to mitigate environmental impact by curbing the demand for resource depletion.

CONFLICT OF INTEREST

The authors have confirmed that there is no conflict of interest with this work.

REFERENCES

[1] Esfahbodi, A., Zhang, Y. & Watson, G. (2016). Sustainable supply chain management in emerging economies: Trade-offs between environmental and cost performance. International Journal of Production Economics, 181, pp. 350-366.

[2] Sarkis, J., Gonzalez-Torre, P. & Adenso-Diaz, B. (2010). Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. Journal of Operations Management, 28(2), pp. 163-176.

[3] Shumon, R., Halim, Z., Rahman, S. & Ahsan, K. (2019). How do suppliers address stringent environmental requirements from buyers? An exploratory study in the Bangladesh ready-made garment industry. International Journal of Physical Distribution & Logistics Management, 49(9), pp. 921-944. doi:10.1108/IJPDLM-08-2018-0305

[4] Bocken, N. M. P., Miller, K., Weissbrod, I., Holgado, M. & Evans, S. (2017). Business model experimentation for circularity: Driving sustainability in a large international clothing retailer. Economics and Policy of Energy and the Environment.

[5] United Nations, "Transforming our world: The 2030 Agenda for Sustainable Development," United Nations, 2015. [Online]. Available: https://www.un.org/sustainabledevelopment/development-agenda/.

[6] Kerkhof, R. v. d. (2018). Innovative by nature Time to act! In.: www.lenzing.com

[7] Muthu, S. S. (2014). 2 - Ways of measuring the environmental impact of textile processing: an overview. In Muthu, S. S. (ed.) Assessing the Environmental Impact of Textiles and the Clothing Supply Chain. Woodhead Publishing, pp. 32-56.

[8] Zhezhova, S., Demboski, G., & Panov, V. (2013). Optimization of technological process of cutting by use of software applications for cut order planning. Tekstil i obleklo, (3), 77-79.

[9] Thomas, R. (2012). Saving Fabric= Increasing Dead Stock. Methods Apparel Consultancy India.

[10] Widanalage, V. L. K., & Kizilirmak, S. (2020). Reducing fabric consumption: by improving marker efficiency.

[11] Kayar, M., Dal, V. & Mistik, S. (2015). Investigating the effect of the marker assortment size distribution and fabric width on the fabric use efficiency. Industria Textila, 66(3), pp. 142-145.

[12] Huang, C. Y. (2014). Analysis on Apparel Marker Making's Technical Requirements and its Influencing Factors. Advanced Materials Research, 834, 1663-1667.

[13] Lakshmanakanth, P. (2012). Spreading and Cutting of Apparel Products. Pg 10. 2012