دليل تصنيع الملابس الجاهزة

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كلية معتمدة

مجلة البحوث في مجالات التربية النوعية

معرف البحث الرقمي DOI: 10.21608/jedu.2021.64009.1267

المجلد السابع العدد 35 .يوليو 2021

الترقيم الدولي

E- ISSN: 2735-3346 P-ISSN: 1687-3424

موقع المجلة عبر بنك المعرفة المصري https://jedu.journals.ekb.eg/

موقع المجلة http://jrfse.minia.edu.eg/Hom

العنوان: كلية التربية النوعية . جامعة المنيا جمهورية مصر العربية

دليل تصنيع الملابس الجاهزة

الملخص:

تعد صناعة الملابس من ركائز الاقتصاد المصري الذي يسجل أعلى معدلات النمو في قطاعات الصناعات النسيجية سنويًا. ومن المعروف أنه لا يمكن إنتاج القماش دون احتوائه على عيوب ناتجة عن عمليات الغزل والنسيج والصباغة والتشطيب.

لذلك من الضروري جدا اقتراح مقياس علمي لضبط جودة الأقمشة المستخدمة.

ان الاختيار الأمثل لمعدات وعمليات التصنيع، وكفاءة العاملين ومهارتهم تعد جميعها عوامل ذات أهمية كبيرة، ولكن إذا كانت جودة الأقمشة غير منضبطة أثرت على جميع هذه العوامل، بالإضافة إلى انه لا يوجد نقص في المعايير ونظم القياس الخاصة بالتنبؤ بالعيوب أو الجودة في تصنيع الملابس.

وتعتبر كرمشة الوصلات قياساً وصفياً جيداً، بالإضافة إلى التقديرات الكمية لقياس جودة الأقمشة ووصلات الحياكة باستخدام نظام تأمين الجودة عن طريق الاختبارات البسيطة (الفاست) ونظام كاواباتا لتقييم جودة الأقمشة بالإضافة إلى (الكيزان – سته "سيجما –"– لين سيجما) وتقترح الدراسة طرق جديدة للتقييم الكمي مثل: (مستوى "السيجما" – الإجهاد النوعي للحياكات – دليل تقييم جودة الملابس الجاهزة).

ويعتبر الزي المحتوى على حد أدني من العيوب جيداً، حيث أنه الشرط الأول لخفض تكلفة الإنتاج، وأيضا يقلل من وقت إعادة إصلاح العيوب.

وقد ثبت أن التوافق بين دليل تقييم جودة الملابس ومستوى "السيجما" كبيراً جداً، وذلك باستخدام دليل قياس درجة اتفاق أو اختلاف الخبراء المعروف ب (معامل كيندل).

الكلمات المفتاحية: أقمشة التريكو – مستوى السيجما لتقدير جودة المنتجات وقياس مستوى أداء العاملين – الإجهاد النوعي للحياكات – دليل تقييم جودة الملابس – معامل كيندل – منحنى باريتو.

Garment Manufacturing Index

Abstract:

The apparel industry is one of the pillars of the Egyptian economy, which annually records the highest growth rates in the textile industries sectors.

It is known that fabric cannot be produced without containing defects resulting from spinning, weaving, dyeing or finishing processes.

And proposing a scientific scale to control the quality of used fabrics and their suitability for use in the apparel industry is undoubtedly an urgent necessity.

Apparel manufacturer's judge a number of aspects of fabric quality, including, subjective assessment factors such as: fabric finger print (FAST/and or KES-F), Kaizen, Deming cycle,6 sigma method, Lean six sigma, and/or objective evaluation factors such as: process sigma level (σ), specific sewing stress (SSS), and garment manufacturing index (GMI).

Defects minimization/and or evaluation is the first condition of reducing production cost and improving the quality. It will also reduce the cycle time by reducing reworks and finally result higher productivity. Concerning this matter, the present study explores the use of Process sigma level – Garment manufacturing index–Specific sewing stress, methodology to evaluate the defects rate in a selected garment factory. The result found after implementation of Kendall's coefficient of concordance "W", both Garment manufacturing index and Process sigma level are very significant.

Keywords:

Knitted Garments, Process sigma level, Specific sewing stress, Garment manufacturing index, Kendall coefficient of concordance ،Partochart, New approach to garment manufacturing index, Garment factory grading.

1-Introduction

According to an MIT report (2015), the global apparel industry produced more than 150 billion garments in 2010. Going through several other sources, we can say that roughly 40% of all garments are produced in China, Bangladesh and India (with total export value of around $200 billion), roughly another 20% comes from nearby countries (Pakistan, Vietnam, Indonesia, etc.) and the rest 40% from all around the globe.[1] . Defects are the most common occurrences in the garment industry. Garment defects may be classified into two main groups:

I-Non-sewing defects such as: Pattern, marking, spreading, cutting, bundling, fattening, ironing, packing…etc.

Ii-Sewing defects such as stitching defects (skipped-staggered-unbalance-broken-needle mark… etc.) Any way if we can control the causes of defects then we can control of rejection of final products.

1.2. Source of defects:

During garments manufacturing different kinds of defects occur in garments. Defects crop up in a garment due to diverse reasons. Types of garment, customer demand, standard of quality, technology used, worker skill etc. greatly affects defect, its source and its severity etc. such as:

1- Fabric, 2-fusing , 3-zipper , 4-button , 5-button holes , 6-velcro , 7-snap button , 8-eyelet grommets buckle, 9-embroidery, 10-sewing construction, 11 -seam stitch,12-pockets/cuffs,13-shade and coloer.14-label,15-pressing , 16- construction and stitching, 17- washing and dyeing, 18-finishing packing. Therefore, quality control covers all the factors and processes of production, which may be broadly classified as below:

1. Quality materials, 2. Quality manpower, 3. Quality of machines, and
4. Quality of management.

In garments industry, inspection is mainly performed in three stages:

(I) Inspection of raw materials, (ii) In-line inspection, and (iii) End-line inspection.

Defect Analysis generally seeks to classify defects into categories, and identify possible causes in yarn, fabric, and garments in order to direct process improvement or determine origination of defect.

- Visual examination
- Microscopic examination
- Physical testing
- Discuss/Report with customer

In garments industry these defects are dependent upon the classification of defects and an inspector's ability to make decisions:

1.3. Fabric defects (Inspection of raw materials-Pre-sewing):

The defects or faults are found in fabric are called fabric defects. Mostly these are not caused by the sewing lines. Running shade, selvedge to selvedge shade, holes, staining mark, missing yarn, foreign yarn, slub, hairiness etc. are the common fabric defects. Fabric defects should be addressed at the point of fabric inspection, or cutting. Fabric defects should not appear at final garments. Fabric defects can further be classified into 3 groups color defects, construction defects and cleanliness.

In the fabric store fabric is being checked before issuing it to cutting department. In general, not all the fabric is checked. Usually 10% of fabrics are checked for good fabric suppliers. For power loom fabric and printed fabric 100% checking is done. Fabrics are checked in flat table, flat table with light box or on fabric checking machine. 4-point system for fabric inspection is used to measure the quality level of the incoming fabric. Examples of these defects are:

Slub, spot, sundry fault, foreign yarn, neps, weft bar, shade bar, hole, missing yarn, thick yarn, knot, wrong shade, Uneven dyeing, Holes, Knitting stripes, Thick & Thin places, Dirt & Stains, Oil stains, Sinker line, Poor softness, Higher Shrinkage, Crease Marks.

i- Workmanship and handling defects (In-line inspection-Sewing):

Such types of defects are directly caused by production section, this would include both the cutting and sewing section. Buyer's approved samples must be referred to maintain perfect workmanship. These defects should never be allowed to raise above a certain percentage. Examples of these defects are:

Body button displaced, half stc at button ,broken button ,slip of stc at side seam ,projection at cuff ,collar ,pocket displaced attached , pocket slanted attached, two ploket hi-low, poket flap slanted attached ,stitching defects in garments, glue stain mark, iron shining mark ,fabric off shading/various shades at SLV, main label slanted attached ,shoulder drop uneven ,needle mark at collar ,band, rejection by snap/metal accessories/wash ,collar point uneven ,bubble at collar ,collar band inside loose ,fraying at body front gathering stc at arm hole ,improper back stc cuff btm ,bad tension at btmstc/jam stc at slv seam ,reverse loop attached ,body button hole broken ,two slv uneven (for short slv),Yoke loose, pleated at side seam, intersection point up-down ,crease mark at upper, hiking at front upper ,lower, skipped stc, unbalance stc, staggered stc, variable stc density ,seam puckering ,bobbin or looped thread breakage ,needle thread breakage, thread fusing when sewing machine stop, Open seam, Puckering, Needle holes & marks, Unbalanced sleeve edge, Unbalanced placket, Insecure shoulder stitch, Incorrect side shape, Bottom hem bowing, Uneven neck shape, Cross labels, Broken & Missing stitch, In secured buttons, Untrimmed threads & fabrics, Poor Ironing, Double stitch.

ii- Trims, accessories and embellishment defects (End-line inspection-Post-sewing):

These defects involve color and placement issues. Maximum such types of defects include color, size and placement of trims such as labels, sewing thread, screen print, embroidery designs, zipper, hangtag, lining, button and any kind of trims

Examples of these defects are:

B/D button up down(over 4cm),collar spread uneven (over 1 cm),tie gap plus or minus (over 3 cm),wrong method folding size, improper clip and pin attached poket slanted, folding side (over 1cm),wrong barcode attached ,defective printed poly and paper band, wrong tie and poly attached, looseness attach poly ,without punch poly, wrong neck board attached, bad looking collar pull, skew collar ,neck button/hole displaced , main label shrinkage, slanted main label/main label bias, improper cuff/sleeve show ,back board show ,back tail show ,pleat near neck, loose folding/crushed folding, bulge at top center, pulling near B/D button ,Yoke loose, top center and main label not straight/top center not straight ,micro dust/stain mark/oil stain ,shoulder side/double fold at shoulder ,collar slip un even, two fly/ rever un even, un even revert width ,skew revere width ,bad shape nose, over lapping collar, folding side at back, Shade variation within the garment parts, Shade variation between the garments, Defective printing, Defective embroidery, Defective buttons

iii- General defects:

Shade variation within the garment parts, Shade variation between the garments, Defective printing, Defective embroidery Defective buttons.

iv- Measurement deviations:

Garment length, Body width Shoulder length, Arm hole, Arm opening, Sleeve length, Placket length, Placket Width, Neck width, Neck opening, Hemming width, Rib or Collar width.

Sewing section is the most important department of garments manufacturing factory. Maximum faults are arising here which hamper the total quality of apparel as shown in Fig (1).

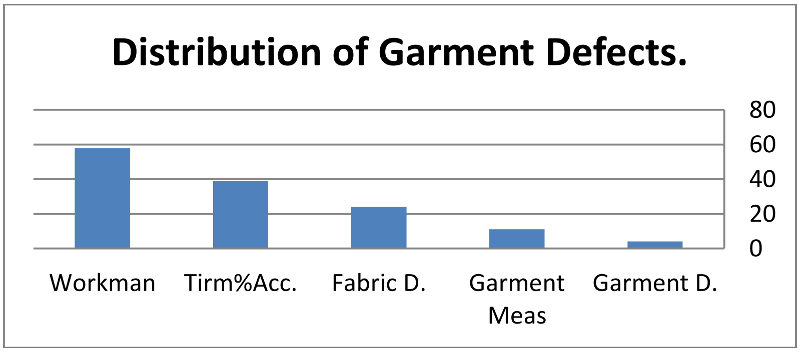

Fig. (1)

It is clear that sewing defects and post-sewing defects are the main causes of garment defects according to Parto analyses.

3-Theoretical Part:

The quality of apparel in the fashion realm is a combination of design and materials of the products which are needed for the intended use and target market it will be sold in. But is that enough? Quality for textile and apparel can be defined as the acceptable level of the goods. Can this be measured? And what should be measured? It is important that your quality control system in place monitors and keeps up in all three of these phases. If the systems are not being controlled and kept up you might risk one of the following occurrences:

- Rejection of products, accessories
- Require outside quality control services (extra expenses)
- Degradation of Factory and Brand Value
- Low motivated employees, nobody wants to get blamed
- May cause for a recall
- Delay in production times

In the apparel industry, we depend on a good quality control system to maximize the production of goods within the specified requirements, doing so the first attempt. Let's look at three examples and how to specify each in your quality control checklist:

a) Specific sewing stress, b) Process sigma level, and c) Garment quality number

3.1-Specific Sewing Stress (SSS):

In garment industry, stitching of different areas of a product is a key character to determine the quality. The efficiency of which depends on strength, elasticity, durability, security and appearance of the constructed seam balanced with the properties of the material to be joined. Seam strength/slippage has been considered as extensively used parameter in the apparel trade for acceptance testing of a product manufactured under a particular international brand.

Testing fabric sew ability using set-up (ST1), [2], this is a device used in many studies on needle penetration force. This equipment simulates a sewing machine by penetrating the tested fabric with an unthreaded needle, with needle count 70. Sew ability was considered to be only fair even though no great difficulties arose during sewing. Specific sewing stress may calculate using formula 1, as follows:

Specific Sewing Stress = Fabric Needle Penetration Force (cN) / Fabric weight (g/m2) x Sewing Needle size / 100 (mm) cN/tex (1), [3]

3.1.1. Modified Fabric Sew Ability Tester (ST2):

Sew ability was considered to be only fair even though no great difficulties arose during sewing. Specific sewing stress "SSS" may calculate using formula (1).

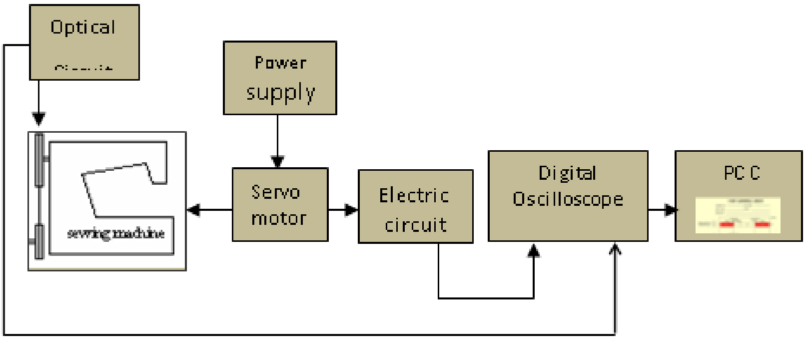

Fig. (2) Fabric sew ability
Sew Ability Tester (ST2), [3-5].

The sewing needle penetration force is the quantities measure of the damage which appears in agreement as the result of the sewing process. A high penetration force means a high resistance of fabric and thus a high risk of damage.

3-2 Process Sigma Level [6-7]:

Here is the five-step process to calculate your process sigma.

Step1: Define Your Opportunities. An opportunity is the lowest defect noticeable by a customer,

Step 2: Define Your Defects,

Step 3: Measure Your Opportunities and Defects,

Step 4: Calculate Your Yield, and

Step 5: Look Up Process Sigma.

Once the number of products, defects, and opportunities are known, both DPMO and Sigma level can be calculated.

1. Defects per opportunity (DPO) = Defect/ (Product x Opportunities). [2]

2. Defects per million opportunities (DPMO) Six-Sigma is determined by evaluating the DPMO, Multiply the DPO by one million.

3. Process Sigma once you have determined the DPMO, you can now use a Six Sigma table to find the process sigma.

3.2.1 Quality Control Checklist:

A quality control checklist—sometimes called an inspection criteria sheet (ICS), is a vital document for inspection and consistent quality of any product, including garments. Your QC checklist for garments should outline dimensional tolerances for the product, any on-site tests you require during inspection and packaging specifications.

A quality control checklist goes by many names—an inspection criteria sheet (ICS), a QC checklist, a quality assurance checklist or quality control sheet. All these names refer to a document that outlines quality requirements and specifications in a clear and concise manner for your supplier, as shown in Fig.2.

company.................. Quality control.................

Line number.............. Line Supervisor................ customer name.............

Total Grade-A	Grade-B	Repairs									Grade-B		Stains	Quantity	Size	
		Total Repairs	flatlock	Band	Bartack	flatlock	Sidestitch	Installing the side seam	Installing the waistband	overlock	Dyeing	Weave	-	700	S M L X L	Printed fabric

2-30	
15	
Crotch hem is notrn existant	10
Defects in the blind stitch of the rubber	7
Difference in crotch	8
Incomplete crotch in the blind stitch	5
Defect in installing the logo	5
The stitching of the logo is visible	10
	2- 3
5 – 30 Holes	

Fig. (3) Product inspection Hangtag

4-Garment Manufacturing Index:

To examine the influence of garment technology on garment quality, sample of knitted garment (men short-women trouser-sweatshirt… etc.)

have been examined. The change (if any) because of apparel manufacturing defects have been inspected by visual assessment. In garments industry, the desired or expected quality parameters are controlled by inspection. This inspection can be done in three steps:

1. Pre sewing defects (n1),
2. Sewing defects (workman defects), (n2)
3. Post sewing defects (trims& accessories), (n3)
4. Garment defects. (n4), and
5. Workmanship (n5).

Where n1, is number of defects found in steps 1, 2,3,4 and 5.

In the mathematical analysis of assessing the quality of garment, the type 1 was counted in tested sample, as n1, while type 2,was counted as,n2,and type 3, was counted as,n3,….and the total number of defects Nt, where:

$$N\,t = n1 + n2 + n3 + n4 + n5 \quad (3)$$

The garment manufacturing index (GMI), which is used in the present work as an inspection measure for quality is calculated by proportions from the following equation:

GMI =100 - (n1/Nt + n2/2Nt + n3/3Nt+n4/4Nnt+n5/5Nt) 100 (4)

Also "n1" is a function of sewing threads, sewed fabric, accessories defects / (buttons, zippers, …. etc., while "n2" is a function of spreading, marking, cutting, sewing, and finishing defects. And "n3" is a function garment defects such as, sizes, puckering, soiling, etc.

4.1. New Approach to Garment Manufacturing Index:

Figure 3 shows the Parto chart of previous garment defects.

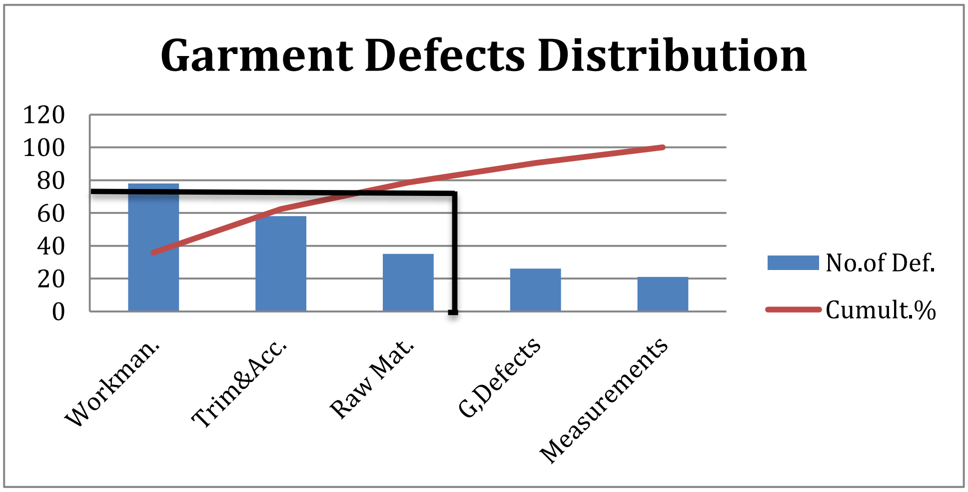

Fig. (4) Parto Chart for apparel defects

It is clear from Fig.2 that, workmanship defects (WD), and trim& accessories(T&A), are the main causes of garment defects Therefor equation (4) may be modified to the following equation:

G.M.I. = 100 – (WD/Nt + T&A/2Nt + FD/3Nt) 100 (5)

where:

WD=No. of workmanship, T&A=No. of trims &accessories, and FD=No. of fabric defects. General speaking, as number of defects decreases, garment defect index increase.

4.2. Classification of garment factories based on garment defect index:

This scale is used to translate garment defect index into letter grades, and vice versa. The Letter grades assigned to each score are provided below.

Grade Scale:

A 100 –80 %

B 79 – 77%

C 76 – 72%

D 71 – 63%

E 62 – 0%

where:

A=Excellent, B= Very Good, C=Good, D=Fair, E=Fail.

Factory will now be required to earn a minimum garment defect index "GDI" of 72-76% to pass a assessment.

5. Experimental Part:

5.1-Materials and Methods:

Properties of tested fabrics are: The weight of commercial samples of knitted in range of 130g/m2 to 300g/m2 were used for testing specific sewing stress, sew ability of tested apparels.

Table I shows the properties of tested knitted fabrics.

Properties	F1	F2	F3	F4	F5
Weight	191.8	197.3	152.4	234	273.3
Thickness	0.57	0.82	0.65	1.12	1.09
Hardness	360	409	333.3	191.5	181.3
Softness	0.125	0.11	0.135	0.235	0.61
Compression Ratio%	51.6	58.5	54.7	56.8	66.8
Air permeability	13.9	22.4	22.4	31.6	19.1
Absorption %	61.4	72.8	74.4	74.6	70.8
Anzotropy	0.67	0.89	0.72	0.58	0.76
Bending Modulus	2.8	0.37	0.18	30.9	36.3
Crease %	49.4	53.6	47.8	63.1	48
Bursting index	13.6	10.4	5.4	10.2	10.2

5.2. Kendall's coefficient of concordance

Whilst the Kendall rank correlation coefficient is used to determine the association between just two variables measured in (or transformed to) ranks, the Kendall coefficient of concordance (W) is used to determine the association between k such variables. It is most commonly used to assess agreement among raters. The coefficient bears a linear relationship to the average Spearman rank correlation coefficient between all possible pairs of raters.

5.2.1. Procedure:

If there are any tied observations, assign the average of the ranks they would have been assigned had no ties occurred.
Find the sum of ranks (RJ) for each item being ranked.
Sum these Rj and divide by the number of items being ranked (N) to give the mean value of the Rj.
Calculate the sum of squares of the deviations of each RJ
From the mean using SS = Σ[RJ−(ΣRj/N)] 2 (6)

Compute the Kendall coefficient of concordance (W) using:
W = 12 S / m2 (n3-n) (7)

5.2. 2. Kendall's rank-order correlation coefficient

The Kendall rank correlation coefficient is another measure of association between two variables measured at least on the ordinal scale. As with the Spearman rank-order correlation coefficient, the value of the coefficient can range from -1 (perfect negative correlation) to 0 (complete independence between rankings) to +1 (perfect positive correlation). Since it is a measure of the linearity of the ranked observations, it provides a test of a monotonic trend of the original data. Kendall's correlation coefficient (τ) (for which we use "rk" for the statistic) is then given by: Kendall's coefficient calculated as above only takes the value +1 to −1 if there are no ties.

6- RESULTS:

6.1. Results of process sigma levels:

Table II. Performance, and Sigma Level, of Existing Process

Styles	Total Sample Size	Total No. of B grade	DPU (8)	Y= e-DPU (9)	σ Level (short term)	Performance Level/ Ranking
Men. Short	600	142	0.237	0.789	0.81	F/3
Men. Shirt	800	350	0.384	0.681	0.47	F/5
Women Trousers	700	93	0.133	0.876	1.16	F/1
Women Comp.	700	125	0.179	0.836	0.98	F/2
M.Sweat shirt	200	58	0.290	0.748	.670	F/4

6.2. Results of sewing machines sew ability:

Table III shows the results of sewing machine sew ability assessment.

Fabric Types	Weight(g/m2)	SSS (cN/tex)/ Ranking
F1 (Jersey)	126	3.492/1
F2 (Rib)	130	1.775/5
F3 (Pique)	140	1.918/3
F4 (Jacquard)	152	2.068/2
F5 (Melton)	170	2.286/4
Average	143.6	2.308/3

6.3. Results of garment manufacturing index:
Table IV shows the results of garment manufacturing index.

Style	Fabric Defects'	Workman defects.	Trims &Accessories	General defects	Measurements.	Total	G.M.I.	Ranking (1) / Ranking(2)
Men Short.	0	40	10	3	1	54	7.9	5/5
Men Shirt	38	87	13	6	3	147	59.8	4/4
Women trouser	150	80	50	11	5	296	71.1	1/1
Women "complizon"	50	115	12	76	3	187	62.2	2/3
Men S.Shirt.	45	50	25	10	2	132	61.5	3/2

It was found that, the coefficient of concordance(W), between results of garment manufacturing index, using equ.4 and that of equ.5. reaches 0.91, i.e.one can use any one of them.
6.4. Results of concordance coefficient's":
In statistics, an index of the degree of agreement between several variables measured on an ordinal scale or transformed to ranks, ranging from 0 (no agreement) to 1 (complete agreement). It may be thought of as similar to Kendall's tau but suitable for measuring the association between more than two variables at a time. Table V shows the results process sigma level and garment quality number for calculating the Kendall's coefficient of concordance.

Table V-Process sigma level vs. garment manufacturing index of tested (5)styles.

Style/Judge	Men Short	Men shirt	Women trouser	Women "Complizon"	Men S.Shirt"
SSS	1	5	3	2	4
Σ	3	5	1	2	4
G.M.I.	2	4	1	3	5

For the data given above:
Kendall's coefficient of concordance can range from 0 to 1. The higher the value of Kendall's, the stronger the agreement.
The p-value is a probability that measures the evidence against the null hypothesis. Lower p-values provide stronger evidence against the null hypothesis. Use the p-value for Kendall's coefficient of concordance to determine whether to reject or fail to reject the null hypothesis.

H_0: The appraiser agreement is due to chance.
H_1: The appraiser agreement is not due to chance.

To determine whether ratings are associated, compare the p-value to the significance level. Usually, a significance level (denoted as α or alpha) of 0.05 works well. A significance level of 0.05 indicates that the risk of concluding that the ratings are associated–when, actually, they are not–is 5%.
P-value $\leq \alpha$: The appraiser agreement is not due to chance (Reject H_0)
If the p-value is less than or equal to the significance level, you reject the null hypothesis and conclude that the appraiser ratings are associated with one another.
P-value $>\alpha$: The appraiser agreement is due to chance (Fail to reject H_0)
If the p-value is larger than the significance level, you fail to reject the null hypothesis because there is not enough evidence to conclude that the appraiser ratings are associated.
It was found that (Specific sewing stress -Process sigma level- Garment quality number):

1. Mean rank = 9
2. Sums of squares = 70

3. W = = 0.77 (strong agreement) (10)
4. we conclude there is a highly significant degree of concordance between the
different raters.

Also, it was found that the value of coefficient of concordance reaches, 'W= 0.8"
(strong agreement)", between specific sewing stress, and garment manufacturing index.

On the other hand, coefficient of concordance reaches its high value, between process sigma level and garment manufacturing index (W=0.9), it may be because they are coming from the same concept.

Conclusions:

In the garment industry, garment production control is practiced right from the initial stage of sourcing raw materials to the stage of a final finished garment. Garment defects problems are still present in garment manufacturing, especially so because of the difficulty to take into account all the relevant factors affecting the manufacturing parameters. This may be the main reason why many of the studies related to reducing number of defects are incomplete due to product type or working conditions. This research aims to fill the gap by proposing a garment manufacturing index: this aims to control all the defects influencing garment quality. Results show that good agreement between this factor and process sigma level /and or specific sewing stress. Garment manufacturing index may be helping detect and reduce the number of defects within the production process.

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