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Acceptable Quality Levels in the Textile Sector and their Effect on the Level of Competition

Abstract
Rapid developments in international competition have obliged textile enterprises to take new approaches in order to gain a competitive advantage. Nowadays, enterprises are placing more importance on creating a structure in which the expectations of consumers are significant. The old approach of "What I produce, I can sell" is being left behind. The limits of acceptable quality levels for the enterprises have fallen back down to critical points due to the effects of liberal policies in international markets. We can see this as a result of the effectiveness of quality control, prevention and valuation from procurement, as well as customer services. Statistical quality control applications are gaining in importance because the textile & apparel sector is a sector in which consumer expectations and preferences are of primary importance.

Key words: *acceptable quality level, quality, textile sector, acceptable quality level in textile sector, standards, statistical process control methods.*

Introduction

Today's increasingly universal market conditions and the ever-increasing production have brought the question of quality to the forefront more than ever. Whereas about 20 years ago quality used only to refer to product quality, today it has become part of our daily life in every aspect.

While the concept of quality has risen in importance, the diversity in products and services has brought about a liberalisation in international trade, the elimination of business boundaries, as well as rises in technological progress and the conditions of competition. Variation and development are concepts which will never be impeded or prevented. The understanding that 'I sell whatever I produce' has had to be replaced with one of 'Producing according to the customer's needs and expectations'; and the only condition for ensuring constant superiority in business competition is to satisfy the customer. To do this, the needs and expectations of the customer should be determined, and the goods and services consistent with these needs and expectations should be presented to the market with lower costs, higher quality and greater speed. To achieve all this, the dimensions of quality, novelty and alteration should be assessed together.

In international trade, 'quality', 'price' and 'punctual delivery' are the most important of the basic factors in competition. Firms who wish to produce quality products should turn their attention toward the market and the customer; establish an appropriate quality/price relationship for their products; train well-educated and -motivated personnel, and have a highly-qualified management system. Therefore, statistical process control methods are being implemented in order to produce goods which are as free of defect as possible. At the beginning of production, while checking raw and semi-raw materials and other supplies obtained from external organisations against specifications, and at the end of production while checking the appropriateness of the product against the specifications and other standards, a 'sampling plan' is effectively being carried out. and the acceptable quality levels indicated.

In this study, we first describe the importance of making a quality product in today's competitive conditions, and the difficulties encountered in doing so; next, the concept of 'sampling plans', which is a very significant aspect of statistical quality control. The standards used by the companies while determining acceptable quality levels for yarn manufacturing, knitting, weaving, finishing, and the ready-made areas of the textile sector are exemplified by samples.

Quality in relation to competition and competition power

The rapid onset of globalisation influences all the subsystems and individuals within the social system. New conditions for competition have emerged as the effects of globalisation, because the only thing which remains stable against the 'winds of change' is the fact that everything is ultimately subject to change.

For this reason, 'variation' is one of the most discussed subjects during the last quarter of the twentieth century. In line with these developments, changes in organisation on both the macro- and micro-levels are inevitable. The factors which force organisations to change are:
- globalisation and competition;
- the growing importance of international and regional integration;
- developments in information technologies; the spread of computer use; the utilisation of robots in the production process, and rapid developments in the field of communication;
- new technological developments;
- newly-opened markets and the race to catch a new share of the market;
- respect for human rights, a concept which is gaining importance in organisations as awareness of human rights and democracy increases;

- customers' consciousness and their changing expectations of quality, fast service, cheapness, the aesthetic value of the product & its reliability, etc.;
- changing demographic structures expressed in terms of gender, language, race and culture differences in the workforce [1].

As a result of the unprecedented economical crisis experienced from the Second World War until the end of the 1970s, an environment of dense competition emerged. In those periods in which technological development was not yet experienced, the fundamental element of competitive power was accepted as the superior method of production. Enterprises which were able to produce large amounts for large markets surpassed their competitors. In the 1970s, technology became widely disseminated in each area of our daily lives, and it was in this period that those enterprises which produced cheaper and implemented new technologies began to compete with less cost. Since the 1980s, a new dimension in competition has opened. Consumers who were hitherto satisfied with cheap and plentiful products now desired quality products. Over time, novelty, flexibility, service and faster accessibility to the market were added to the concept of quality. Enterprises of the 1990s have been directed toward distinct approaches by many factors, prominent among which are the increase in productivity provided by technological developments; globalisation of world markets, the transition process into an information society; the increasingly short lives of products; the fall in time available to offer new products on the market, and constantly changing customer requirements.

Many factors determine the competition power of enterprises, the most important of which are the following:

Production and cost: Enterprises should implement methods which will reduce the production costs in the best manner by preventing worse quality, among others. Diminishing costs strengthen the position of companies on the market by means of price advantage [1, 2].

Quality and appropriateness to standards: Those enterprises in which a quality subordinated production and meeting the needs and expectations of customers was adopted can maintain their advantages against their competitors. In particular, those companies which produce products or services which conform to international quality standards, will have a competitive advantage on both internal and external markets.

Skilled workforce: After 1980, employees' wages lost their significance as the main factor in determining competitive power. In industries which have involved in an increasingly competitive environment, the cost of unskilled workforces has diminished [1]. From that point, an employer's competitive power based on reduced wages could no longer be seen as an advantage. In the frame of this new structure, where wages were not the main factor in determining competitive power, a skilled and trained workforce gains much more importance [1, 2].

Production technology and R&D activities: Technology has changed traditional enterprises to an unrecognisable degree and affected new enterprises. Those enterprises which want to maintain their competitive advantages on national and international markets and want to make these advantages constant should choose appropriate technologies which can produce products of higher quality and in a shorter time than their competitors. Just as important as technology, R&D activities are also a factor affecting competitive power. Today's countries which show such power can be characterised by investments in R&D activities [1, 2].

Market share: When an enterprise decides to enter onto the domestic or external market, it should determine the market share to be targeted as well as the strategies to be followed in achieving that target. Market share has become an important element in competition. In many situations, those enterprises which have reached the targeted market share have advantages in competition when compared to their competitors [1, 2].

As a result of a research carried out by TUSIAD (Turkish Industrialists' and Bisnessmen's Association) in 38 sectors in order to determine the criteria of competition for firms in important sectors in Turkey, the contributions of the criteria of competition mentioned above to the firms' competitive power were investigated, and the findings were graded from 1 to 10 (10 represents the highest importance and 1 the lowest). The following criteria defined competition superiority: cost of workforce, productivity of workforce, cost of capital, quality, characteristics, dissimilarities, technology, infrastructure, availability of raw material, internal competition environment, image of nation, and foreign connections. Here 'quality' stands for the possibility of reaching an international level in quality; 'characteristics' stands for the possibility of reaching an international standards in products; 'dissimilarities' stands for the ability to create products and services that have unique characteristics. In all sectors, the most important determinant was 'quality', followed by 'characteristics', 'technology', 'availability of raw material', and 'productivity of workforce' [1].

Based on the primary factors of competitive power mentioned above, the factors influencing a firm's international competitive power can be grouped under two categories: **Intra-company factors;** the quality, cost and price of the products are the most important. Cost factors, such as the costs of workforce, capital, import, taxes and social security should be considered. Besides them, the productivity, profitability, information technology being used in the firm, organisation and management structure, effective use of sources, innovation and creativity are the essential intra-company factors determining the international competitive power [1].

Extra-company factors; The role of the government in the economy and its intervention therein is the leading factor. Furthermore, the international business system (especially protectionism and free business systems) are also understood to be important. In free business systems, there is no way that a government can intervene in international business. In foreign business systems which are called protectionist, some sectors of government are protected against the possible adverse affects of foreign competition. Protectionism is one of the obstacles to the development of competitive power. It is not possible to expect those enterprises, which are under continuous governmental support and protection, to increase their competition power on their own. On the contrary, in an international business system in which free business is in effect, enterprises feel themselves obliged to promote their quality, minimise their costs and use resources effectively, in order to compete with other enterprises. Therefore, the enterprises' competition power tends to increase constantly [1].

Among the extra-company factors that affect international competitive power, the customers' level of knowledge is also important. Those knowledgeable customers who constantly look for quality, innovation in goods and services, and who ask for more than what they already have, also put pressure on enterprises to develop constantly.

Sampling plans and acceptable quality level

Today, in order to produce which are as little defective as possible, statistical process control methods are being used. Nevertheless, no matter how effective these methods are, it is inevitable that a small amount of defective production will occur. Therefore, enterprises should seek to accomplish the following:
- to inspect the work done at the end of production;
- to prevent defective products from reaching other organisations and customers, and
- to check whether the raw, semi-raw and finished products received from other organisations under particular contracts are in accordance with those contracts [3].

Thus, to determine whether the product is acceptable, samples taken at various stages are inspected. Sampling for acceptance is a process of taking certain amounts of the production and examining it to see if the mass (bulk or party) conforms to predetermined quality specifications, and to evaluate, and accept or reject it accordingly. The inspection process can generally be accomplished through sampling, except for those products which possess vital and functional features. The objective is to describe the main mass (party) with the help of the sample quality [3].

When purchasing raw material, semi-finished or finished goods, the following questions should be considered;
- Are the incoming piles (of tools) or groups (of pieces) fully appropriate to the quality described by standards?
- If so, what is the degree of conformability?
- According to their quality, can this pile or group be accepted [3]?

In order to proceed more economically, these questions can be answered after checking a certain portion (not the whole pile or group) by sampling. Sample inspection plans are carried out in four ways [4]:
1. the single-layer sampling plan (SLS),
2. the double-layer sampling plan (DLS),
3. the multiple-layer sampling plan (MLS), and
4. the sequential sampling plan (SS).

The single and double-layer sampling plans are the most preferred in applications. Sampling for acceptance can be studied in two groups (the second is much more widespread than the first):
- for measurable characteristics, and
- for immeasurable characteristics [4].

Single-layer sampling plan (SLS)

This is a way of taking a decision to accept or reject the party by examining the units taken from the party only once. Here, a random sample of n units is obtained from an N product party. Flawed/flawless inspection is carried out on the samples, and the number of defect goods (d) is determined. For the acceptance of a preset party, the following comparisons are made with the highest number of defective goods (c) that could exist in the sample [4].

If $d < c$, then the party is accepted.
If $d > c$, then the party is rejected.
For example, a sampling plan that has $N = 100$, $n = 5$, $c = 2$ is a single-layer sampling plan; according to this plan, a sampling with 5 is taken from the upcoming party with 100 units and examined. When there are 2 or fewer defective units, then the party is accepted; otherwise it is rejected [4].

Double-layer sampling plan (DLS)

Distinct from the above, a second chance is given to the party. More attention should be paid during application.

n1: The sampling width which was chosen first from the party with N units.
n2: The sampling width which was chosen second from the party with N units.
c1: The highest number of defects accepted for the first sampling.
c2: The highest number of defects accepted for the second sampling.
d1: The number of defects in the sampling with n1 units.
d2: The number of defects in the sampling with n2 units [4].

The function of the plan is as follows [4];
- Sampling with n1 is taken from the party with N.
- If $dl < c1$, then the party is accepted.
- If $d1 > c2$, then the party is rejected.
- If $c1 < d1 < c2$, a second sample with n2 unit is taken.
- If $d1 + d2 < c2$, the party is accepted.
- If $d1 + d2 > c2$, the party is rejected.

One of the important considerations in sampling is accepting what the n1, n2, c1, c2 values would be. Therefore, enterprises utilise either customer requests or ready sampling plans such as MIL STD-105D. Some examples related to sampling for the acceptance plans used by various textile firms are given below.

Acceptable quality level determined according to customer requests

Because many firms (especially those in the textile sector) make bulk productions on commission, they consider customer requests when determining their acceptable quality levels. Table 1 shows the n and c values depending on the number of orders prepared for a double-layer sampling plan by a ready-made product towel production firm in Denizli, Turkey [9]. For example, if the incoming order quantity is 100, then 13 samples are taken from production and tested; if the number of defective products is 1, the party is accepted; if 3, it is rejected; if 2, then another control is carried out. This time 20 samples are checked; if there are 2 defective products the party is accepted; if there are 3 defective products, the party is rejected. The defects are examined under three groups, major, minor and critical flaws; major and critical flaws are considered as significant defects (Table 2).

Acceptable quality level determined according to ready sampling plans

The project of sampling plans and its applicability to varying conditions requires extensive statistical and contingency measurements. The frequent use of these measurements in the examination process carried out by quality experts during the production process is not practical. Therefore, in addition to the acceptance sampling plans determined by firms according to customer requests and international standards, other tables are used, such as the Dodge-Romig tables, which consist of standard sampling plans to protect customers against poor quality, as well as MIL-STD 105D (the Military Standard Tables 105 D, which although they were developed during the Second World War are still in use today) and MIL

STD-1OSA, which include acceptance plans which protect the manufacturer against a high rejection risk of good-quality parties. Furthermore, a civil standard plan similar to this program, called ANSI/ASOCC Z 1.4, is available [4].

The ***Dodge-Romig Tables*** were created for examinations of SLS and DLS based on the criteria of mean quality level (MQL), or through a party tolerance (PT) acceptability of a good at the undesirable level of quality by the customer (β). The Dodge-Romig tables are divided into four groups (PT tables of SLS, and DLS, MQL tables of SLS, and MQL tables of DLS); in all these tables, sampling for acceptance plans was done in such a way as to minimise total examination. The mean number of defects and the number of samples (n) according to the magnitude of the party are determined, as are the acceptable number of defects. These tables are not used when the agreements made depend on decisions for sending parties back to the manufacturer [4].

The ***MIL-STD-105D tables*** can be used both for the rate of defects and the number of defects. These tables were formed to find N, n and c according to the types of sampling and examination depending on criteria such as the magnitude of the party and the acceptable quality level. MIL-STD-105 D can provide a normal sampling plan for a determined acceptable quality level, a level of examination, and for a certain magnitude of the party, as long as manufacturers produce goods of an acceptable or better quality level. When there is sufficient evidence related to the inferiority of quality, strict sampling plans are given instead of normal plans. The choice of MIL-STD-105 D is generally SLS, DLS or MLS plans. The selection of one of these types is made considering various factors, although its selection generally depends on its usefulness in administrative applications. For example, using DLS for acceptance has a certain psychological advantage for the party being examined, as it is not rejected after only one sampling. When considering costs, however, the opposite is true. as the cost is the highest for MLS, and the lowest for SLS. Besides, quality control experts of a complex acceptance plan should obviously be more careful, specialised in their areas and experienced [4].

The stages in utilisation of MIL-STD-105 D can be summarised as follows;

Table 1. *Sampling for acceptance plan determined by the firm.*

Number of orders	Number of controls	Accepted	Rejected
1-8	All of them	0	1
9-90	5	0	2
	13	1	2
91-150	13	1	3
	20	2	3
151-280	13	1	4
	32	3	4
281-500	20	1	6
	50	5	6
501-1200	32	2	8
	80	7	8
1201-3200	50	3	11
	125	10	11
3201-10000	80	5	15
	200	14	15
10001-35000	125	8	22
	315	21	22
35000-150000	200	12	22
	315	21	22

Table 2. *Flaws and their degrees of importance determined by the firm.*

Flaw code	Flaw	Critical	Major	Minor
C1	Free loop		X	
C2	Unknotted thread end		X	
C3	Number of loops out of the limits of determined tolerance If collar knit is under minimum values If other areas and collar knit is over tolerance	X	X	
C4	Defective appearance		X	
C5	Insecure stitches		X	
C6	Stitch style is different		X	
C7	Variable knit tension Apparent (has affect on appearance) Less apparent		X	X
C8	Wrong weighting and disordered loop line		X	
C9	Other flaws		X	X

1. An acceptable quality level is selected.
2. The level of examination is established (loose, normal, tight).
3. The magnitude of party (N) is determined.
4. From the relevant table (Table 1) a code letter for the measurement of sampling is selected depending on the magnitude of the party and the type of examination.
5. The sampling plan is determined (single, double or multi-layer) and recorded in the relevant table.
6. The code letter established from Table 1 and the corresponding sample volume/volumes and the numbers accepted and rejected, overlapping with selected acceptable quality levels, are read.
7. Decisions (accepted/rejected) related to the party are made by making inspections according to sampling plan [4].

Standards used in determining product quality in the textile sector

Standardisation is understood as an organisation of fundamental principles for firms that have to increase their competitive powers in the world market. Variation taking place in the market due to developing economical integration, increasing competition and specialisation occurring in the world has made it imperative that business be carried out within certain rules.

Although it is easy to compare prices today, determining the level of a product's quality is much more complex. Today, as in other production areas, starting from the fibre to the finished product, all the tests used and the evaluations made in producing textile products are carried out according to the standards already prepared in these areas.

Regarding the textile sector is considered, standards can be categorised as follows;

- Test and inspection standards: the standards used in determining linear density, length staple, tenacity, elongation at break etc. during evaluating the fibres; and additionally the standards used for yarns, twist, unevenness etc.; the standards used in some woven fabric characteristics, such as warp and weft density, area-weight, resistance to breaking off, resistance to ripping off, air permeability, etc.

- Standards related to terms, definitions, categories and degrees: the designations and symbols used in determining the textile threads and in fibres, cotton baling regulations, identifying flaws in woven clothes, etc.

- Standards applied to processes and products, such as fibres, threads, cloths, dyeing, finishing and performance of the finished product (such as fastness experimental methods for dyed and pressed textile products).

- Organisational standards related to company functions and their relationships: quality standards used for system and services: e.g. ISO 9000 quality management and quality assurance standards (ISO 9001, 9002, 9003 and 9004), standards for system, and production management.

- Standards related to health, security of customers and environment: e.g. reliability standards concerning burning of textiles, standards for ISO 14000 environmental management system, Ecotex standards, etc.

- In order to ensure quality production, a textile enterprise should use intra-company standards, business standards, national and international standards, and perform controls based on those standards.

Business standards and operational standards used in the textile sector

In production, especially when made for export, the consignee's standards and those used in the export market apply. Business standards determine the level of quality of the product to be sold in the market.

There are also a set of quality standards, such as the results of the market survey, statistics, organisational data, etc. However these standards have some disadvantages, such as not taking shelf-life into account, being rarely renewed, having unhelpful sampling rates, etc. Therefore, quality standards which are more extensive and which are used in business life are needed.

Business standards are related to the level of quality required by the market. The business agreement made between vendor and customer provides the connection. However, the manufacturer should set forth their performance standards, regardless of the business agreements. These are defined as operational quality standards. The purpose of the operational quality standards is to enable the measurement of the quality performance of the enterprise, and to inform management in this regard. When standards for different quality characteristics are identified and the responsibilities of the personnel related to this matter are determined, then if deficiencies concerning materials occur and standards are not met, then the management personnel may reveal the problem and take necessary precautions. But, if objective quality indications are not available, then the management cannot evaluate the quality performance.

It is not easy to form operational standards. Realistic standards should be devised by considering the feasibility of the process, quality of material and the abilities of the workforce. It will not be beneficial to form higher standards, since customer requests could be fulfilled through existing machines and materials.

In the textile sector, one of the most important business standards valid in the market are the Uster Statistics used in the yarn business. The Uster Statistics, prepared by the Uster company, involve statistics related to characteristics of quality, starting from raw materials of cotton fibres and other various types fibres of threads through to intermediate products, such as strips, roving yarns and threads [5].

The most important aspect of the Uster Statistics are nomograms (Figure 1 is an example) that demonstrate levels of quality as percentage curves for subject parameters. Percentage curves stand for the percentage of total world production equal to or exceeding the measurement values given for a particular yarn or fibre [5].

The aim of the thread producer is to be able to make products with an acceptable quality level from less expensive fibres. In addition to the characteristics of raw material used in yarn operation, the quality features of semi-finished and finished products are compared through the Uster Statistics, and the percentage that the company's production falls into is determined. A level of 5% in the Uster Statistics should not be interpreted as very good. On the contrary, a level of 5% might be an indication of high cost and high price. Similarly, a level of 95% should not be interpreted badly; it may indicate the right quality for an attractive price and target markets [5].

The Uster Statistics related to the characteristics of raw cotton fibre were developed with Uster HVI and Uster AFIS. In the nomograms of Uster Statistics, HVI and AFIS parameters and percentages showing a certain share of world cotton production have been drawn according to staple length. Table 3 lists the most significant cotton quality parameters measured by HVI and AFIS devices included in the Uster Statistics [5].

Quality reference values established during purchasing cotton by a yarn company are given below. When these values are compared by the Uster Statistics, it can

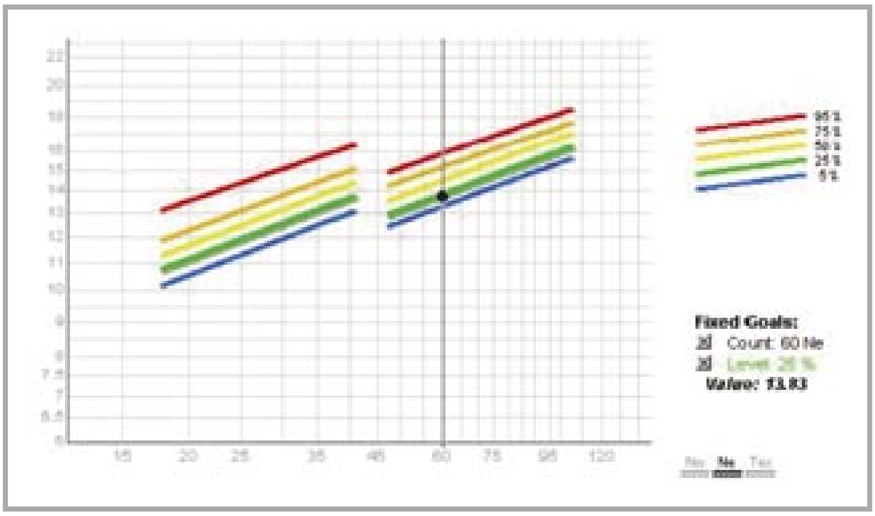

***Figure 1.** Mass variation graphic for a 100 % cotton combed ring-spun yarn.*

be seen that they equal 75% of world production [5].

By utilising the Uster Statistics, thread manufacturers can determine acceptable intra-operation quality levels for yarn characteristics. Characteristics of carded and combed yarns in spool and kop forms were given separately in the Uster Statistics 2001. Data related to the following raw materials are available; 100% cotton ring-spun, rotor-spun, compact, PES, viscose, wool, polyacrylonitrile; 65-35% PES/cotton; 65-35% PES/viscose; 55-45% PES/wool; 50-50% PES/cotton. Yarn quality characteristics were measured by using a Uster Tester 4, as well as the Tensorapid and Tensojet devices. A description of the most important quality characteristics related to yarns is given in Table 5 [5].

Besides the Uster Statistics, the Premier Statistics prepared by Premier Company are also used. In the Premier Statistics, the quality references are presented for roving and yarns in kops. The Premier Statistics prepared in 1998 are comprised of different sections depending on the final product in which cotton yarns are used: combed-yarn tricot, and warp, carded-yarn tricot and warp. Each section presents graphs related to 4 basic yarn characteristics; lack of smoothness, total number of flaws, yarn resistance and elongation, together with fibre characteristics located at the x axis: 2.5% span length, resistance, microner value, trash and lack of smoothness ratios. Two curves for the maximum and minimum values determine the qualities covered by at least 25% of enterprises [6].

The statistics formed as a result of measurements carried out worldwide by the Uster and Premier Companies offer great possibilities and advantages to yarn customers, but in other fields of the textile sector, such as knitting, weaving, finishing and ready-made clothing performance, standards prepared in this manner do not exist, and firms determine quality values according to customers' requests [6].

As an example we may present the description of a quality control report established according to customer requests by a dye company functioning in Çorlu, Turkey [9]. It consists of various sections such as general information related to the goods (customer, party number, type of cloth, design number, volume etc); raw commodities' raw width, area weight, goods return, raw and length measurements after shrinkages, classification of defects seen in raw and finished goods, the section fastness value, and standards to be used in purity measurements. The washing fastness requested by the enterprise is 4, wet friction purity is 3, dry friction purity is 4, acidic and basic sweat perspiration purity is between 3-4, and the colour difference value (ΔE) is between 0-1 intervals. After the cloth control report is filled out, and after the necessary measurements have been conducted, it is sent to the customer for approval.

As in further examples, Table 6 [9] shows the most important quality standards established by one ready-made manufacturer, whose main office is in Switzerland but which makes a very significant part of the production in Turkey. If the samples produced are within the predetermined values, then approval for production is obtained.

Another example may be the quality requested by a customer related to T-shirts produced in 4 distinct types (Table 7) [9].

Table 3. *Quality features of the cotton fiber.*

Features of quality	Abbreviation	Description	Unit
Microner	Mic	Shows thinness of the fiber	Microner
Length of upper half	UHML	Counterpart of stapel length	Mm
Smoothness Index	UI	A measure of changes occurred in fiber length.	%
Resistance of pinch	Resistance	Resistance of fiber in bunch shape	g/tex
Reflection	Rd	Reflection degree of the cotton	%
Yellowness	+b	The degree of yellowness	%
Remains	CNT	Number of remains in a particular area	-
Remains	Area	Number of remains in a particular area	%
Nepp	Nepp/g	Number of nepp in 1 gram cotton	1/g
Seed husk nepp	SCN/g	Amount of seed husk nepp in 1 gram cotton	1/g
Amount of short fiber	SFC (n) SFC (w)	Amount of short fiber in regards to number and weight	%
Length of upper quarter	UQL (w)	Length corresponding to stapel length	mm
Thinness of fiber	Thinness	Thinness of fibers	mtex
Amount of unripe fiber	IFC	Percentage of unripe fiber	%
Amount of rubbish trash	Trash/g	Amount of trash in 1 gram cotton	1/g
Dust	Dust/g	Amount of dust in 1 gram cotton	1/g
Visible foreign matter	VFM	Amount of visible foreign matter	%

Table 4. *Values of quality characteristics established by a firm.*

SPIN LAB HVI 900			AFIS						
2.5% length of span	% UR	Resistance, cN/tex	SFC (n), %	Ripeness rate	Nep, qty/g	SCN, qty/g	Dust, qty/g	Trash, qty/g	VFM, %
28,5	82	828	25	0,89	550	20	850	300	5,0

Table 5. *Description of yarn quality characteristics.*

Quality characteristics	Abbreviation	Description	Unit
Thread number variation	CVcb	Number change between spools	%
Lack of smoothness (mass)	CVm	Mass variation coefficient	%
Lack of smoothness (mass)	CVmb	Mass variation coefficient between spools	%
Defective areas	Thick, thin, neps	Number of thick & thin and neps	1/1000m
Featheriness	H	The average length of feathers per 1 cm threat	Unitless (cm/cm)
Standard deviation of featheriness	SH	The standard deviation of featheriness in one stool	Unitless
Dust, remains	Dust remains	Amount of dust and remains per 1 m thread.	1/1000m
Variation coefficient of diameter	CVd	Variation in yarn diameter	%
Shape	Shape	The shape of the yarn cross-section, the rate of eclipse at the axis	-
Density	D	Density of yarn	g/cm3
Tensile strength	Fh	Breaking force	CN
Tenacity	Rh	Breaking force per linear density	CN/tex
Coefficient of variation of tenacity	CVRh	Variation in tenacity	%
Elongation	CH	Elongation yarn at break of yarn	%
Coefficient of variation of elongation	CV_{CH}	Variation in elongation	%
Break off process	W_H	Work to break	cNcm
Coefficient of variation of work to break	CV_{WH}	Variation of values of the work to break	%
Weak areas in threat / resistance	$F_{HP=0.1}$	Resistance of 0.1% of all the tests is under this value	cN
Weak areas in threat / elongation	$C_{HP=0.1}$	Elongation of 0.1% of all the tests is under this value	%

National and international standards used in textile sector

When the importance of standards was understood, each country founded its own organisation of standards, but these organisations remained confined to the national level for a long time. Today, the developing economical social order, the intense transfer of technologies and the constant development of these processes with international connections, have made uniformity in national and international standards imperative.

At the national level, standards are prepared by each country. In certain cases, these standards are better-known than some international standards. For example, in the United Kingdom, the BS-English standards prepared by the British Standards Institute are used. The BS 5750 quality management system is a standard equivalent to ISO 9000. In the United States, the ANSI/ASQC 9000 standards published by ASQC and adapted by American National Standards Institute are equivalent to ISO 9000. Similarly, in Canada, France (AFNOR), Germany (DIN), India (BIS), Denmark (DS) etc, similar standards have been devised.

In addition, national and international standards related to textiles are used, such as the physical, mechanical and performance appearance standards for textiles published by the world–renowned ASTM (American Society for Testing and Materials), and the textile chemicals and dyeing standards published by AATCC (the American Association of Textile Chemists and Colourists). In Turkey, as of 1997 there are 726 standards wich have been released by the Turkish Standards Institutes (TSE) [8].

The ASTM Standards provide values for the general performance standards of various textile products without making material discrimination. For example, standard ASTM D3477 ('Standard Performance Specification for Men's and Boys' Woven Dress Shirt Fabrics') is a performance standard devised for men's woven shirts. The performance characteristics described in this standard are shown as an example in Table 8 [7].

At the international level, the most widely-used standards concerning textiles were developed and published by ISO (the International Standardisation Committee). These involve various types

Table 6. *Quality standards established by a ready-made firm and its requests.*

Test	Standard method	Value requested
Change of dimension	EN ISO 6330 EN ISO 3759 EN 25 O77 or ISO 5077	In woven clothes: Width: ± 3 Length: ± 3 In knitted clothes: Width: ± 5 Length: ± 5
Appearance	5 washes	Nothing changed
Colour purity against washing	EN ISO 6330 EN ISO 3759 ISO 5077 (with household type washing machine and Ariel for coloured clothes)	Fading degree: 4 Becoming soiled: 3-4
Friction purity	EN ISO 105-X12	Dry: 3-4 Wet: 3
Water purity	EN ISO 105-E01	Fading degree: 4 Becoming soiled: 3-4
Purity of water with chlorine	EN ISO 105-E03 (50 mg/l concentration)	Fading degree: 4
Sweat purity	EN ISO 105-E04	Fading degree: 4 Becoming soiled: 3-4
Pilling in knitted clothes (ICI pilling box)	EN ISO 12945-1 (Test should be done before washing)	Wool / mixtures / elastan mixtures: 7200 cycles: 3 Others 14400 cycles: 3
Pilling in woven clothes (Martindale)	EN ISO 12945-1 (Test should be done before washing)	2000 cycles: 3
Resistance of tearing	EN ISO 13937-2	Outer clothes / blouse / garment > 10 N Inner clothes > 15 N Jacket / duffle coat > 20 N

Table 7. *T-shirt characteristics established according to customer requests*

Characteristic		Type 1	Type 2	Type 3	Type 4
Type of material		100% cotton		50% polyester, 50% cotton, Tolerance = ± 5	
Type of knit		Supreme	Interlock	Supreme	
Square metre weight (g/m^2)		160 ± 15	200 ± 15	195 ± 15	150 ± 15
Density of knit (Minimum) (qty/cm)	Number of loop sticks	14	11	12	13
	Number of loop rows	22	13	15	19
Explosion pressure, min				600	
Colour purity against commercial and household type washings (minimum)	Flowing	4	4)	4	3-4
	Fading	4-5	4-5	4	4
Colour purity against friction (minimum)	Dry	4-5	4-5	4	4
	Wet	4	4	4	3-4
Colour purity against sweat (minimum)	Flowing	4	4	-	-
	Fading	4	4	-	-
Colour purity against weather conditions (minimum)		4-5	4-5	-	-
Sweat and light purity (minimum)		-	-	3-4	3-4
Dimension variation after washing (%) (Maximum)		When T-shirts are washed as a whole in accordance with the conditions of TS 57200 Chart-1 process no. 5A, none of the measurements of height, width and sleeve length will show stretching or shrivelling higher than 5 (five)%.			
pH		4,0 – 7,5			
Touch		Will not be tougher than the touch of cloth at the basic sample			
Collar ribana		It will be knitted at 1×1 ribana knitting, by using cotton and elastomer thread to include 3% elastomer thread as a weight. While in free situation the number of loop sticks will be at least 10 sticks/cm, and the number of loops will be at least 12 rows/cm.			

Table 8. *Performance characteristics of ASTM D3477.*

Characteristics	Minimum value requested		Test method
Resistance of break off	Min 111 N (25 ıbf)		D 1682
Thread slip	67 N (15 ıbf)		D 434
Resistance of tearing	6.7 N (1.5 ıbf)		D 1424
Dimension variation	At each direction max 1%		AATCC method 135
Friction purity	Dry	min 4	AATC method 8 AATC method 116 (at pressed products)
	Wet	min 3	
Sweat purity (acidic)	Fading at colour	min 4	AATCC method 15
	Getting soiled	min 4	
Light purity	min 4		AATCC method 16
Dry cleaning purity	min 4		AATCC method 132

of standards released by the ISO Textile Committee TC 38 concerning textile, standards released by Technical Committee TC 72 related to textile machinery, and standards of quality management systems released by TC 176, such as ISO 9000 and ISO 10000.

Conclusion

Today, where competition is at the highest level, enterprises that can produce accumulated technological knowledge, and can make their production flexible while considering the market variability, gain very high competitive power by providing their customers with products of higher quality, which are appropriate to standards, and are available at lower prices. Thus, enterprises should do the following to increase their competitive power: establish closer relations with their customers, meet their expectations of production quantity and time, assess complaints, observations and satisfactions separately, ensure continuity in their development by comparing their products with others', and direct upcoming work on the basis of the market information which they have analysed.

In the textile sector, as has occurred in each sector of industry, standardisation and the standards formed for this purpose provide great advantages for the national economy and world trade as well as for the manufacturers themselves. In the rapid globalisation process in industry and business, along with the developments in information and production technologies, many textile firms have become able to exceed their scope beyond national boundaries thanks to the elimination of economic limitations. From now on, the way to compete on international markets leads through the production of quality goods consistent with standards – standards which have become a common language in international trade. However, firms are establishing their intra-firm standards according to customer requests, and the tolerance is continually decreasing. Especially in enterprises that make commission production and determine product quality according to customer requests, deviations from the acceptable quality level may result in many problems emerging between the manufacturer and the customer, such as increases in costs, loss of customer and market, and requests for reduction in prices.

With the intensifying competition, and putting the concept of 'total quality' into practice, it appears that firms which function according to the concept of 'acceptable quality level' (AQL) have no other choice but to adopt a 'zero defect' (ZD) policy. The perception of AQL is replaced by the perception of '100% quality' or 'ZD'. In the past, customers would accept goods with 1%, 2%, or even 5% defects; today they satisfy their needs with companies whose production error levels are measured in ppm (parts per million), ppb (parts per billion) or ultimately ZD. To guarantee 100% quality through examination is impossible. Therefore, manufacturers are increasingly abandoning the control of products, preferring instead to control the system producing that product. Today, this is not enough; characteristics that guarantee quality are included in the project of the process, and even in the project of the product. Recently, because the emphasis placed on human health and the environment has increased, the importance and effectiveness of the standards have risen in this regard. As mentioned in the ISO 14000 environmental standards, EKO-TEKS100 standards and others are concrete indications of this. Therefore, Turkish firms should promote the quality levels of their products intensively, and should ensure that they are consistent with present standards. This is the only way for them to become institutionalised.

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