(REFEREED RESEARCH)

DETERMINATION OF ILLUMINATION CONDITIONS IN APPAREL MILLS

KONFEKSİYON İŞLETMELERİNDE AYDINLATMA KOŞULLARININ BELİRLENMESİ

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ABSTRACT

Objectives of this paper include determination of illumination types and values in apparel mills in Izmir and designation of current situation about illumination in these mills. In this study, illumination measurements at the time of production have been performed in 10 apparel mills. A general estimation of illumination used in apparel mills in Izmir province has been aimed by comparing the present statues of the mills and standard values of Ministry of Labour in Turkey. The results have been given in the form of tables and figures which have been discussed in relation to one other. It has been observed that there are major differences in the illumination types used and the illumination values applied in the mills are higher than the standard values of Ministry of Labour. During the study, the knowledge level of the mills about the illumination was increased and performing the same work more efficiently with less energy consumption provided. Utilization rate of light has been increased by method study.

Keywords: Illumination, Standards of illumination, Ergonomics, Apparel mills, Working conditions

ÖZET

Bu makale İzmir ilinde yer alan konfeksiyon işletmelerinde kullanılan aydınlatma çeşitlerinin ve aydınlatma değerlerinin saptanarak mevcut koşulların belirlenmesini amaçlamaktadır. Araştırma için 10 konfeksiyon işletmesinde üretim süresinde çalışma ortamı aydınlatma değerleri ölçülmüş, Çalışma Bakanlığının ilgili tüzükleri ve standart değerleri ile kıyaslanarak İzmir ilindeki konfeksiyon işletmelerinin geneline ilişkin bir yargıya ulaşılması hedeflenmiştir. Sonuçlar tablolara ve grafiklere dökülmüş, gerek kendi içinde gerekse diğer tablolarla ilişkilendirilerek tartışılmıştır. İşletmelerin kullandıkları aydınlatma çeşitlerinde büyük farklılıklar göze çarpmış, elde edilen verilerin standartların çok üstünde olduğu gözlemlenmiştir. Çalışmaların yürütüldüğü sırada işletmelerin aydınlatma konusunda bilgi düzeyleri yükseltilmiş, aynı işin daha verimli ve daha az enerji tüketimi ile yapılması sağlanmıştır. Metot etüdü çalışmalarıyla, ışıktan yararlanma oranı artırılmıştır.

Anahtar Kelimeler: Aydınlatma, Aydınlatma standartları, Ergonomi, Konfeksiyon işletmeleri, Çalışma koşulları

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1. INTRODUCTION

The harmony of "human, tool and equipment, working environment" has a great effect on organisation success. While mills are arranging several education and improvement programs for the adaptation of laborers to the working environment and tool-equipment or appropriateness of these tools for the laborers, physical rearrangements are being performed in the working environment.

Issues such as laborers' health and safety are gaining much more importance due to the fact that the apparel industry is more labour-forced from the view point of production structure compared to other industrial branches. Working under the circumstances of physical and psychological difficulties affects not only the laborers' health but also prevents their productivity.

Physical working conditions in apparel mills are as follows;

- Climate (temperature and humidity conditions)
- Illumination
- Level of noise (1).

It is essential to have a good illumination technique in order to perform every single process perfectly and protect the laborers' health. First of all, illumination is necessary for perceiving all the details required by the quality standards in all work procedures and processes. It serves the same objective from the viewpoint of eye health and vision clarity of the laborers' working under the optimum illumination circumstances (2).

High visibility of tools, products and other related data during production is a base factor increasing the production, decreasing loss and preventing the visual fatigue and headaches. Besides, it is necessary to mention that visual inadequacy and glare are frequent causes of work related accidents.

Visibility is due to several factors; size of the processed item, visibility range,

perception of the image, light density, colour of the processed item, level of light according to the background and colour contrast. All these factors have to be investigated in detailed works, in dangerous environments or in the works which cause complaining and dissatisfaction. In general, illumination is the most important factor that can be easily corrected (3).

It is also known that the highest illumination is not the optimum approach. The optimum illumination is the approach that serves the objective. Criteria such as laborers' eye health, high level of work skills, optimum efficiency and the level of illumination at which the laborers' feel themselves comfortable are used in the design of illumination project (2).

80% of human activities are controlled by eye, which eventually results in eye fatigue and when the eye is forced, work related accidents can increase; therefore, the illumination of the mills is extremely important. As a result of researches, illumination was found to have an effect of 14-40% on the performance (4).

In previous studies, how the artificial illumination is used in the working environment (5), the effect of illumination on eye fatigue (6, 7), the effect of fluorescent light vibration frequency (8), the measurement of glare lighting (9), the effect of illumination changing on laborers' performance (10, 11), determination of required optimum lighting levels (12), principles of good lighting (13) have been investigated.

To the best of the authors' knowledge obtained from the literature, illumination types and values in apparel mills are investigated for the first time in this study.

2. Material & Method

Experimental work of this research has been performed in middle and large scaled apparel mills registered with Aegean Region Chamber of Industries in Izmir. Measurements were carried out in 10 mills using tools that have been obtained from Ege University Textile and Apparel Industry Application Research Center.

During the measurements, an electronic Luxometer (Lux & fc Light Meter) with a measurement range of 0-50.000 lux, was used (see Figure 1). The average illumination values of each department were obtained using a total of 437 units of measurements which were made in specific places of every department. Explanations were done using these average values. Measurement points were determined considering the visual level of laborers and their work desks (see Figure 2). However, in warehouses the general illumination level was measured.

Factors affecting the measurement values are as follows;

- The main factor affecting the measurement value is whether there is daylight in the measurement point or not because daylight increases the illumination value, which results in an increase of the average values.
- In case artificial lighting is used, the distance between the light source and the measurement surface is extremely important. Thus, optimum level for the lamps has to be chosen.
- Cleaning and maintenance of artificial lighting is quite important. Old and new lamps with the same power output (kW) have different illumination values (lux).
- It is necessary to have covers over the lamps regarding laborers' health and security. However, these covers have to be cleaned periodically. Illumination values decrease in a noticeable rate owing to the dust layer (1).

In 1958, the Illuminating Engineering Society (IES) has published illuminance recommendations in table form. These tables cover both generic tasks (reading, writing etc), and 100's of very specific tasks and activities (such as drafting, parking, milking cows, blowing glass and baking bread).

All tasks fall into 1 of 9 illuminance categories, covering from 20 to 20,000 lux. The categories are known as A - I, and each provide a range of 3 illuminance values (low, mid and high) (see Table 1).

Table 1. IES Illuminance Categories and Values - For Generic Indoor Activities (14, 15)

ACTIVITY	CATEGORY	LUX
Public spaces with dark surroundings	A	20-30-50
Simple orientation for short temporary visits	B	20-75-100
Working spaces where visual tasks are only occasionally performed	C	100-150-200
Performance of visual tasks of high contrast or large size	D	200-300-500
Performance of visual tasks of medium contrast or small size	E	500-750-1000
Performance of visual tasks of low contrast or small size	F	1000-1500-2000
Performance of visual tasks of low contrast or very small size over a prolonged period	G	2000-3000-5000
Performance of very prolonged and exacting visual tasks	H	5000-7500-10000
Performance of very special visual tasks of extremely low contrast	I	10000-15000-20000
A-C for illuminance over a large area (ie. warehouse, lobby space) D-F for localized tasks G-I for extremely difficult visual tasks		

Figure 1. Luxometer

In the light of these standards, the values below were determined at the beginning of the study on the basis of apparel mill departments in order to provide guidance for these mills (Table 2). During the calculation of these values mean ages of the laborers and light reflection rate of the working surface have been considered by using procedures of the IES method.

Table 2. Appropriate illumination levels for the departments

Departments	The Illumination Level (Lux)
Sampling	300
Model-Pattern	500
Cutting	300
Classification	500
Sewing	500
Ironing	500
Quality Control	900
Warehouses	300

3. Results

In this study the measurements were carried out in 8 different departments of apparel mills. Measurement figures were calculated based on the department size and one set of measurement was planned to be performed for 70 m^2. Because of the differences in sizes of the same departments in different mills, the number of measurements differed from one another. The numbers of measurements performed in different mills are presented in Table 3.

Table 3. The number of measurements obtained from each department of apparel mills

Departments \ Mills	A	B	C	D	E	F	G	H	I	J	Total
SAMPLING	4	4	4	2	4	3	4	4			29
MODEL-PATTERN			2	2	2	2	2	2			12
CUTTING	8	8	6	10	28	9	9	9	12	8	107
CLASSIFICATION	2	4					3				9
SEWING	12	5	6	7	12	12	9	14	12	16	105
IRONING	3		3		3	3	6	3	4	8	33
QUALITY CONTROL	9	7	9	10	8	6	7	15	15	14	100
WAREHOUSE	10		4	4	4	6	6	8			42
										Overall	437 Units

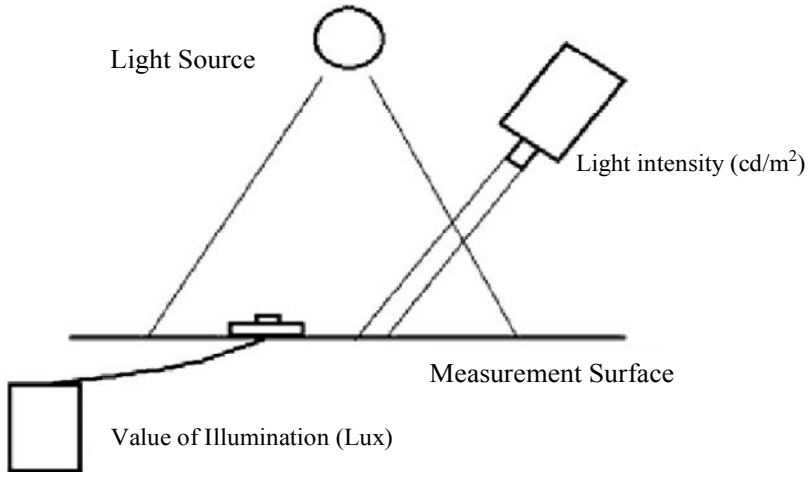

Figure 2. Measurement of illumination

As can be seen from Table 3, it wasn't possible to obtain illumination data of 8 departments of some mills. The basic reason for this situation is that some of the mills perform this work via custom manufacturing or the department doesn't exist within the mill where the measurements are obtained. For instance B and D mills do their ironing via custom manufacturing. The classification department of some mills is combined with the cutting department therefore illumination measurements of this department could be obtained only in A, B, G mills. Owing to the known effect of daylight on illumination, the measurements were carried out in the same period of the day in every mill. By considering the seasonal differences in daylight time, the measurements were conducted between the hours of 12:00-15:00 in winter period and 14:00-17:00 in summer period.

As a result of applications, the average values of illumination from 10 mills are presented in Table 4.

Table 4. Average values of illumination obtained from departments of apparel mills

DEPARTMENTS	A	B	C	D	E	F	G	H	I	J	Average (Lux)	Standard (Lux)
SAMPLING	621,75	586,75	1575,75	285,5	1211,25	1916,33	791,5	1688,5			1084,66625	300
MODEL-PATTERN			1648	350	1282,5	1329,5	290,5	311,5			868,6666667	500
CUTTING	566	565	1070,33	340,6	1250,71	749	1000,88	1139,44	585	729,62	799,658	300
CLASSIFICATION	594	544,5					862,33				666,9433333	500
SEWING	643,25	724,6	553,33	333	795,41	842,66	642	1079,57	658,41	837,62	710,985	500
IRONING	638		493,33		2040	1463,33	499,5	1166,33	656	546,87	937,92	500
QUALITY CONTROL	735,33	757,71	483,88	381	1486,37	739,16	383,85	1340,93	911,93	922,5	814,266	900
WAREHOUSE	129,6		200,25	79,25	393,5	312,5	402,83	186,87			243,5428571	300

The average values which were measured in different departments of the mills and their relation with the standards mentioned above (Table 2) are demonstrated in Figure 3.

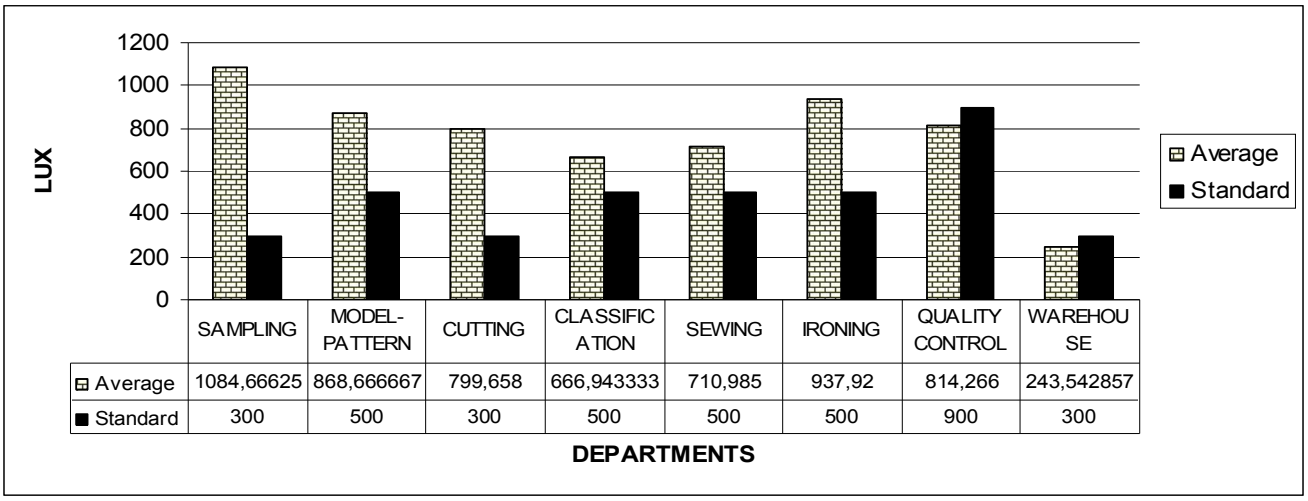

Figure 3. Comparison of illumination values obtained from departments with the standard values

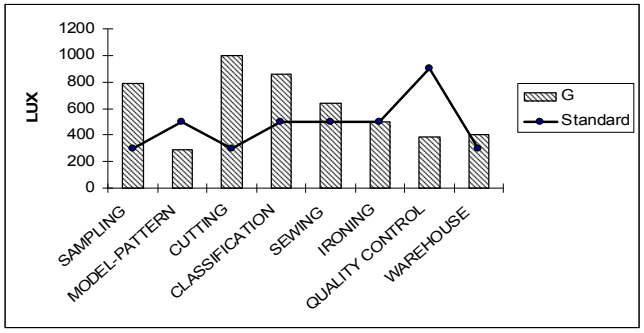

Figure 4. Comparison of illumination values of each department in G mill with the standard values

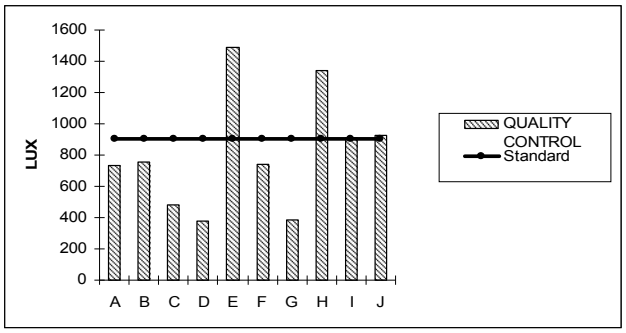

Figure 5. Comparison of the illumination values of quality control departments of each mill with the standard values

Based on the results of Table 4 the evaluations below can be done;

1- The illumination values of each department can be compared with the standard values. In Figure 4, the measurement results of G mill are evaluated.

When the values obtained from the G mill are observed, all the other illumination values except for quality control and model pattern departments are greater than the expected standards.

2- The individual illumination values of any department from 10 different mills can be compared with the standard values. Comparison of the illumination values of quality control and cutting departments with the standard values is presented in Figure 5 and 6, respectively.

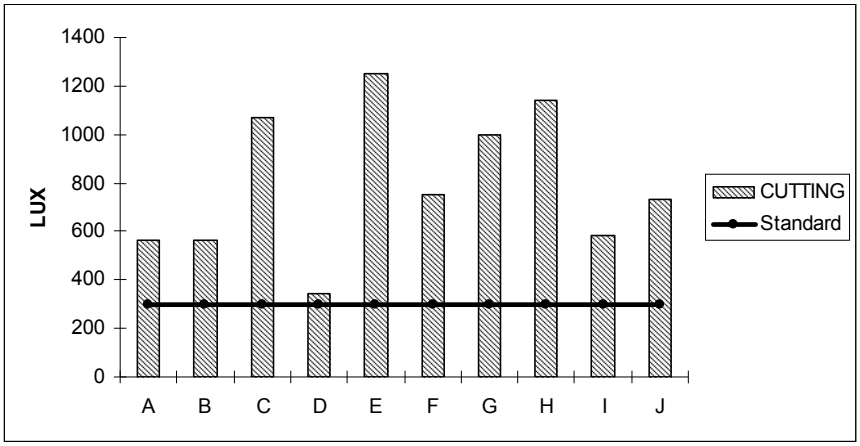

Figure 6. Comparison of the illumination values of cutting departments of each mill with the standard values

As can be seen from the results, measured illumination values obtained from the same departments in different mills differ from one another. The reasons of this situation will be discussed in the next section.

4. Discussions

When the average measurements are observed, the illumination values used in many departments are greater than normally required whereas in quality control department the situation is just the opposite. However, quality control is the last process before the product reaches the consumer. It is strange that the managers who complain about the rejected orders don't give the necessary importance to this subject.

Different problems occur in the case of making evaluations in terms of mills where the measurements were performed. For instance, the reason for low illumination values of some departments in mill A is insufficient cleaning and maintenance of the fluorescent lamps and their covers. Moreover, different values of illumination were obtained from different types of covers. Therefore, a standard system can be developed for the units in which the fluorescent lamps are positioned in order to obtain a standard illumination.

In mill E the illumination values are higher than those obtained in the other mills. Since this mill is located on the top floor of a building, daylight affects illumination values directly. At the same time, the power of fluorescent lamps used in this mill is lower than those in the other mills in terms of "kW". Consequently, both the illumination values and electrical costs are high.

It will be advantageous to use artificial illumination instead of daylight in the departments such as quality control where the colour of light is important.

5. Conclusions & Recommendations

The aim of the study presented herein was to analyse the illumination types used in apparel industry and to compare the illumination values with standard values of Ministry of Labour. Although illumination problems can be solved by little precautions, simple solutions and cheap projects in apparel industry where the laborers' efficiency gains greater importance, there is no research about the enhancement of illumination in the apparel mills. The measurements and determination of defectiveness in this area will cause great benefits to the apparel industry.

An analysis of the obtained data of illumination and observations leads to the following conclusions and recommendations:

- ✓ When daylight illumination is preferred, the places of workstations, machines and looms have to be chosen by considering the direction and intensity of light. Basic approaches such as preventing the glare of daylight on working surface, avoiding direct and intensive light from laborers' eye and choosing places of machines and operations according to required illumination diligently have to be considered.
- ✓ In order to strengthen the illumination achieved by daylight artificial illumination has to be used. Artificial illumination should not only be considered as illumination system which is used to support inadequate daylight. The basic approach is balancing the illumination level by considering inadequacy of daylight illumination.
- ✓ In artificial illumination projects, the required level of illumination in the whole work place has to be taken into consideration. While the light sources are distributed in every place of the factory for artificial illumination, special light sources have to be used in the places where detailed processes are performed. Several details such as layout, internal partition, columns and ceiling structure have to be are considered in preparation of illumination projects within the factory.
- ✓ It is essential to always keep the windows clean inside and outside the building. Maintenance of illumination devices has to be performed by considering the breakdown period of the lamps, decreasing of light efficiency due to the fact that lamps get dusty, dirty and also the colours of the reflective surfaces become dull within time. Permanent and periodic maintenance should not interrupt the work order and also in case of emergency situations precautions should be taken for maintenance processes.
- ✓ Level of illumination has to be changed according to the contrast of material and background.

- ✓ Glare occurs due to the high levels of illumination, which will cause abrasive situations for laborers. In case of such situations, reflection factor should be reduced by changing the colour properties of reflective surfaces.
- ✓ Vibrations in the fluorescent lamps occur in the rear ends, which may cause perceptual disorder. To prevent this, it is advisable to cover the rear ends of the lamp tubes.
- ✓ By changing the direction of light coming over the worked material, some parts of the material can be perceived in details and also it is possible to make the glare parts dull with this method. This method is called "modelling". It is suggested that modelling technique should be used in the departments such as quality control in which the details have to be considered.
- ✓ It is necessary to consider the physiological effects of colours on the laborers.
- ✓ To rest the eyes of the laborers is also important. In order to fulfill this provision, the laborers should prefer to look at the objects, which are away and not glaring.
- ✓ Level of illumination also affects the way of sitting. Therefore, ergonomics has to be considered in determination of illumination levels.

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