International Conference on Multidisciplinary Sciences (icomus)
15-16 December 2018 © İstanbul/Turkey

# THE VISUAL DISPLAY OF ILLUMINANCE IN INDOOR SPORT HALLS WITH THE DEVELOPED SOFTWARE

# KAPALI SPOR SALONLARINDAKİ AYDINLIK DÜZEYİNİN GELİŞTİRİLEN YAZILIMLA GÖRSEL OLARAK GÖSTERİLMESİ

1. Mehmet KAYAKUŞ[1], 2. İsmail Serkan ÜNCÜ[2]

## Abstract

*The healthy vision conditions can be achieved by lighting designs and applications made for their own purposes in the competitions held in the indoor sports halls. EN 12193 Lighting and Light - Sports Lighting (2009) standard, which was accepted on 09.04.2009 in our country, and EN 12193 Light and Lighting - Sports Lighting (2007) accepted in December 2007 in Europe, are used for the lighting standards of sports halls. There are also some standards determined by federations for basketball halls. These standards are based on the principle of broadcasting. In our country, Turkey, "The Compliance and Safety Instructions of the Hall" (2017) determined by Basketball Federation; in Europe, "The Official Basketball Rules Basketball Equipment" (2017) determined by FIBA (Fédération Internationale de Basketball) are the standards for lighting and measurement. Lighting measurements in indoor sport halls are measured based on the level of illumination determined by the activity level. In this study, the values of the illumination of a sample indoor sport hall was measured. The illumination was mapped by the software developed for a more meaningful and visual expression of this quantitative (lux) information measured by using a lux meter. For this purpose, the indoor sport halls are divided into equal areas of 4 $m^2$ and the average illumination values of these areas is calculated. The illumination values in the range determined by creating a colour scale are expressed in different colours. Thus, low and high illuminated places are presented visually.*

**Keywords:** *1st Sport hall, 2nd lighting, 3rd software, 4rd image processing,*

## Özet

*Spor salonlarında müsabakaların sağlıklı görme koşullarında yapılabilmesi, amacına uygun olarak yapılmış aydınlatma tasarımları ve uygulamaları ile sağlanabilir. Spor tesislerinin aydınlatma standartları için ülkemizde 09.04.2009 tarihinde kabul edilen TS EN 12193 Aydınlatma ve Işık - Spor Aydınlatması (2009) standardı, Avrupa'da da Aralık 2007 tarihinde kabul edilen EN 12193 Light and Lighting - Sports Lighting ( 2007) standardı kullanılmaktadır. Basketbol salonları için federasyonların belirlediği standartlar da bulunmaktadır. Bu standartlar yayın yapılma ilkesine dayanmaktadır. Ülkemizde Türkiye Basketbol Federasyonunun belirlediği "Salon Uygunluk ve Güvenlik Talimat"ı (2017), Avrupa'da FIBA (Fédération Internationale de Basketball)'nın belirlediği "Official Basketball Rules Basketball Equipment" (2017) aydınlatma ve ölçüm standartları bulunmaktadır. Spor salonlarında aydınlatma ölçümleri aktivite seviyesine göre belirlenen aydınlık düzeyi temel alınarak ölçülmektedir. Bu çalışmada örnek bir spor salonunun aydınlık düzeyi değerleri ölçülmüştür. Lüksmetre kullanılarak ölçülen bu sayısal (lüks) bilgilerin daha anlamlı ve görsel olarak ifade edilebilmesi için geliştirilen yazılım ile aydınlık düzeyi haritalandırılması yapılmıştır. Bunun için spor salonu 4 $m^2$'lik eşit alanlara ayrılmış ve bu alanların ortalama aydınlık düzeyi değerleri hesaplanmıştır. Bir renk skalası oluşturularak belirlenen aralıktaki aydınlık düzeyi değerleri farklı renklerle ifade edilmiştir. Böylece az ve fazla aydınlatılan yerler görsel olarak sunulmuştur.*

**Anahtar Kelimeler:** *Spor salonu 1, Aydınlatma 2, yazılım 3, görüntü işleme 4*

[1] Dr. Öğr. Üyesi, Akdeniz Üniversitesi, mehmetkayakus@akdeniz.edu.tr
[2] Doç. Dr., Isparta Uygulamalı Bilimler Üniversitesi, serkanuncu@isparta.edu.tr

## 1. INTRODUCTION

In recent years, also in consideration of the modern lifestyle of the industrialized countries (Ståhla vd., 2001), the sport is gaining an increasingly important social role, both among adults than among children (Alexandru, 2015).

Basic goal for sports lighting is to provide an appropriate luminous environment for athletes and spectators. Design parameters include quantity of illumination, discomfort glare, contrast, and illuminance uniformity. Criteria for sports lighting are often stated in terms of maintained average illuminance, maximum to minimum illuminance ratio (Max:Min), and coefficient of variation(CV), all of which are defined below (Houser vd., 2013).

In most of the year, the indoor sports areas used for long hours should be provided with the necessary illumination level values and the relevant parameters for performing physical activities (Özenç ve Güler, 2009). Disregarding scientific facts, unplanned and hasty applications lead to a large amount of energy loss (Yavuz vd., 2006).

## 2. BASKETBALL LIGHTING STANDARDS

The lighting system in a sports facility should ensure good visual conditions for players, athletes, referees, spectators, and (if present) for TV shots. To achieve adequate lighting conditions is necessary to optimize the perception of visual information during the performance of sports events, maintaining the correct levels of visual performance and provide an acceptable level of visual comfort (Fantozzi, 2016).

The EN 12193 standard, which was adopted in 2007 for sports lighting in Europe, is in force (EN 12193, 2007). This European standard deals with sports lighting to ensure good visual conditions for players, athletes, referees, spectators and CTV transmission. “EN 12193 Light and lighting - Sports lighting” standard is used for lighting of sports facilities. Table 3 assist in the selection of the lighting class (EN 12193, 2007).

**Table 1.** Selection of the lighting class (EN 12193, 2007)

| **Level of competition** | **Lighting class** | | |
|---|---|---|---|
| | **I** | **II** | **III** |
| International and National | * | | |
| Regional | * | * | |
| Local | * | * | * |
| Training | | * | * |
| Recreational/School sports | | | * |

Class I is top level competition such as international and national competition which will generally involve large spectator capacities with long potential viewing distances. Class II is mid-level competition such as regional or local club competition which generally involve medium size spectator capacities with medium viewing distances. Class III is low level competition such as local or small club competition which generally do not include spectators.

General training, physical education (school sports) and recreational activities will also come into this category (EN 12193, 2007).

### 2.1. Horizontal Illuminance

The illuminated playing surface forms a major part of the field of view for the players, officials and spectators. It is the illuminance on this horizontal plane, at ground level, commonly referred to the horizontal illuminance ($E_h$), that chiefly serves to establish the adapted state of the eye, by creating a stable visual background against which people and objects will be seen. Because of this and because the illuminated field is necessary for the players, spectators and cameras as a visual background, an adequate horizontal illuminance on the court is important (EN 12193, 2007).

To ensure safety of movement for the spectators when entering and leaving the stands or surroundings, adequate horizontal illuminance in these areas is also required.

Table 2 indicate the lighting requirements necessary for indoor and outdoor basketball events.

**Table 2.** Lighting standard of basketball halls (EN 12193, 2007)

| Class | Horizontal illuminance | | Colour rendering index ($R_a$) |
|---|---|---|---|
| | $E_{average}$ (lx) | $E_{min}$ / $E_{ort}$ | |
| I | 750 | 0.7 | 60 |
| II | 500 | 0.7 | 60 |
| III | 200 | 0.5 | 20 |

Basketball halls are composed of two parts as principal area and total area. Principal area(PA) is actual playing area needed for the performance of a certain sport. Total area(TA) generally comprises the principal area (PA) and an additional safety area outside the principal area (EN 12193, 2007). There are grid points for lighting measurements in the basketball hall. The TA and PA dimensions and the number of grids are shown in Table 3.

**Table 3.** Lighting standard of basketball halls (EN 12193, 2007)

| | Reference Area | | Number of grid points | |
|---|---|---|---|---|
| | Length | Width | Length | Width |
| Principal area(PA) | 28 | 15 | 13 | 7 |
| Total area(TA) | 32 | 19 | 15 | 9 |

If television broadcasting; lighting standard of basketball halls are shown in Table 4.

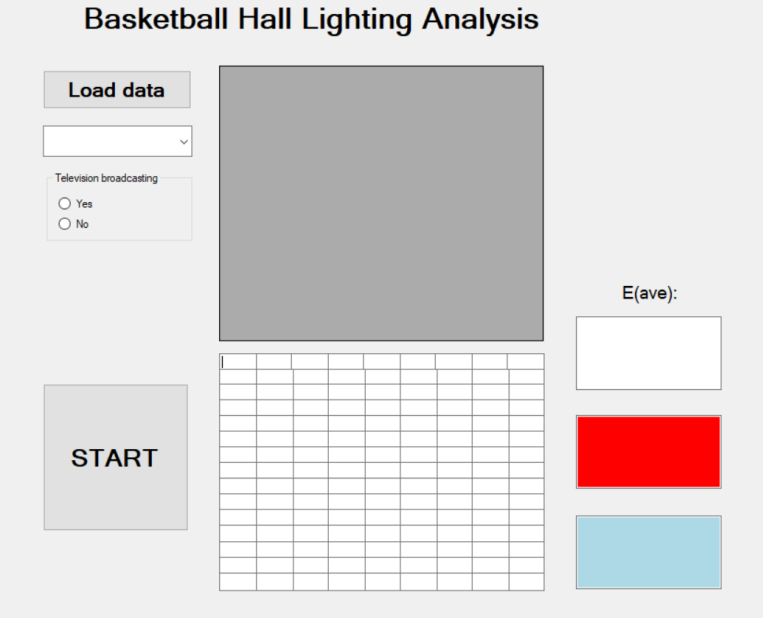
**Table 4.** Lighting standard of basketball halls (television broadcasting) (FIBA, 2017)

| Class | Horizontal illuminance | | |
|---|---|---|---|
| | E (lx) | $E_{min}$ / $E_{max}$ | $E_{min}$ / $E_{ave}$ |
| I | 1500-3000 | 0.7 | 0,8 |
| II | 1050-2100 | 0.7 | 0,8 |
| III | 500-2000 | 0.6 | 0,7 |

## 3. LIGHTING ANALYSIS SOFTWARE

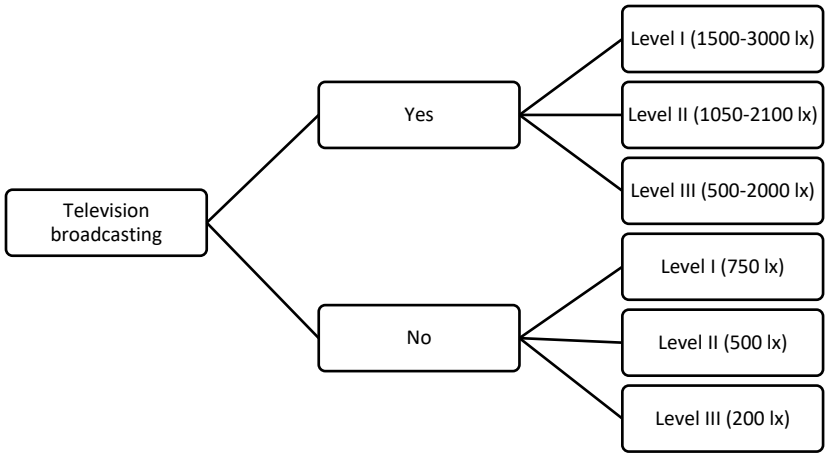
The lighting measurements in the indoor basketball hall were made using the luxury meter in the total number of grids in the total area. The software, as shown in Figure 1, is developed in C # programming language. Measurements in basketball field are recorded in excel (.xls) format. In the program, the user firstly loads the data in excel format using the "Load Data" button.

**Figure 1.** Basketball hall lighting analysis software




After installing the data into the system, the purpose of the hall is determined. The purpose of the basketball hall for lighting is shown in Figure 2.

**Figure 3.** Basketball hall lighting values




Then, by clicking on the start button, the user determines the fields that provide the desired values and do not provide them according to the purpose of usage of the basketball hall.

## 4. EXPERIMENTAL MEASUREMENTS

The test phase of software was performed at Gazi Mustafa Kemal Sport Hall in Akdeniz University. The indoor basketball hall shown in Figure 2 has a capacity of 800 people and is suitable for making matches at national level.

**Figure 2.** Sport Hall



The lighting measurements in the indoor basketball hall were made using the luxury meter in the total number of grids in the total area. The software, as shown in figure 2, is developed in C # programming language. Measurements in basketball field are recorded in excel (.xls) format. In the program, the user firstly loads the data in excel format using the "Load Data" button. The data uploaded to the software are shown in the DataGridView as shown in Figure 4.

**Figure 3.** Basketball hall lighting measurements

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Lighting analysis using software in this hall is shown in Figure 4. In these figures, the values that provide the illumination values are shown as light blue and the values that do not provide them are shown in red color.

**Figure 4.** Lighting analysis

| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
|---|---|---|---|---|---|---|---|---|
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Television broadcasting (YES)
Level I

| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
|---|---|---|---|---|---|---|---|---|
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Television broadcasting (YES)
Level II

| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
|---|---|---|---|---|---|---|---|---|
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Television broadcasting (YES)
Level III

| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
|---|---|---|---|---|---|---|---|---|
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Television broadcasting (NO)
Level I

| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
|---|---|---|---|---|---|---|---|---|
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Television broadcasting (NO)
Level II

| 811 | 812 | 817 | 793 | 775 | 823 | 815 | 836 | 834 |
|---|---|---|---|---|---|---|---|---|
| 995 | 1000 | 1028 | 1039 | 1048 | 996 | 1017 | 1020 | 1014 |
| 1110 | 1127 | 1159 | 1189 | 1197 | 1197 | 1207 | 1169 | 1157 |
| 1220 | 1252 | 1266 | 1324 | 1341 | 1353 | 1334 | 1307 | 1282 |
| 1325 | 1320 | 1366 | 1412 | 1428 | 1467 | 1465 | 1423 | 1395 |
| 1334 | 1347 | 1381 | 1435 | 1452 | 1502 | 1523 | 1485 | 1452 |
| 1319 | 1344 | 1378 | 1426 | 1441 | 1522 | 1536 | 1512 | 1432 |
| 1287 | 1309 | 1332 | 1425 | 1463 | 1508 | 1539 | 1470 | 1530 |
| 1246 | 1277 | 1290 | 1425 | 1477 | 1486 | 1529 | 1514 | 1505 |
| 1200 | 1247 | 1313 | 1404 | 1465 | 1458 | 1502 | 1527 | 1549 |
| 1160 | 1190 | 1284 | 1388 | 1450 | 1473 | 1485 | 1495 | 1508 |
| 1110 | 1155 | 1252 | 1353 | 1421 | 1438 | 1445 | 1460 | 1490 |
| 1040 | 1076 | 1160 | 1262 | 1305 | 1325 | 1330 | 1343 | 1363 |
| 984 | 1030 | 1076 | 1100 | 1188 | 1182 | 1184 | 1200 | 1216 |
| 819 | 860 | 889 | 880 | 956 | 857 | 1034 | 1012 | 1023 |

Television broadcasting (NO)
Level III

The number of points that provide / do not provide ideal lighting is given numerically in the software. The numerical values are shown in Table 5.

**Table 5.** Number of ideal lighting grid points

| | | Number of points | |
|---|---|---|---|
| | | İdeal illumination | Not ideal illumination |
| Television broadcasting (YES) | Level I | 0 | 135 |
| | Level II | 45 | 90 |
| | Level III | 116 | 19 |
| Television broadcasting (NO) | Level I | 135 | - |
| | Level II | 135 | - |
| | Level III | 135 | - |

## 5. RESULTS

In parallel with the developing technology, lighting measurements are also facilitated and improved. Lighting measurements are expressed in numerical values using the luxury meter. However, it is difficult and time consuming to express and analyze these numerical values.

Thanks to this software, well and insufficiently illuminated points can be expressed visually according to the hall. Thus, it facilitates the work of expert staff and saves time.

In addition, the software provides numerically well and insufficiently illuminated points. In this way, the information about the whole hall can be obtained.

Bu çalışma Akdeniz Üniversitesi Bilimsel Araştırma Projeleri Koordinasyon Birimi tarafından desteklenmiştir. Proje Numarası: 3899 (This work was supported by The Scientific Research Projects Coordination Unit of Akdeniz University. Project Number: 3899)

## REFERENCES

Alexandru, M.A. (2015), "Sport – A Solution to the Social Integration of Children with Conduct Disorders? Pilot Study", **Procedia - Social and Behavioral Sciences**, Vol.180, pp.1297-1303.

EN 12193 (2007), Light and Lighting - Sports Lighting.

Fantozzi, Fabio- Leccese, Francesco-Salvadori, Giacomo-Rocca, Michele- Garofalo, Marco (2016), "LED Lighting for Indoor Sports Facilities: Can Its Use Be Considered as Sustainable Solution from a Techno-Economic Standpoint?", **Sustainability**, Vol.8, No 7, pp. 1-13.

FIBA (2017), Official Basketball Rules: Basketball Equipment.

Houser K.W.-Royer, M.P.-Mistrick, R.G. (2013), "Light Loss Factors for Sports Lighting", **The Journal of the Illuminating Engineering Society of North America (LEUKOS)**, Vol.6, No 3, pp. 183-201.

Özenç, S.-Güler, Ö. (2009) "Kapalı spor salonlarının aydınlatma verimliliği bakımından incelenmesi", **V. Ulusal Aydınlatma Sempozyumu**, 7-10 May, İzmir, Turkey.

Ståhla, T.- Rüttenb, A.-Nutbeamc, D.-Baumand, A.-Kannasa, L.-Abele, T.-Lüschenf, G.- Rodriquezg, D.J.A.-Vinckh, J.- Zeei, J. van der (2001), "The importance of the social environment for physically active lifestyle -results from an international study", **Social Science & Medicine**, Vol.52, No 1, pp. 1-10.

Türkiye Basketbol Federasyonu (2010), **Salon Uygunluk ve Güvenlik Talimatnamesi.**

Yavuz, C.Y.-Akın, İ.-Yalçın, M.A. (2006), "Enerji verimliliği ve aydınlatma bileşenleri bakımından stat aydınlatması incelemesi: Sakarya Atatürk Stadı", **6. Ulusal Aydınlatma Kongresi**, 23-24 October, İstanbul, Turkey.