VV (02)/ 2020 | Journal of science and technics of physical and sports activities
ISSN 2661-7668

The effect of indoor luminous environment on the comfort of chess players

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Received: 21/10/2020 ; **Revised:** 25/10/2020 ; **Accepted:** 27/10/2020

Abstract: Chess is considered one of the cognitive sports neglected by Algerian leaders, especially in southern Algeria. The objective of this study is to assess the lighting comfort of chess players in the city of Biskra from an analysis of four virtual games room models equipped with different shading devices. This study was based on several simulations of the illuminance of virtual chess rooms using Radiance software. The main idea of this research is to objectively assess the impact of shading devices on the light comfort of chess players, in order to propose a model that ensures the performance of players by effecting their visual tasks naturally, without resorting to artificial lighting. This paper suggests that the architectural devices studied are more effective during the summer period. In addition, this study shows that these devices provide a comfortable light environment for chess players at different times of the day. The findings of this research also show that the best architectural feature of the south-facing chess room window is the Light-Shelf, that it reduces uncomfortable surfaces of chess tables due to very high light. Concerning the field of sport in Algeria, future research is recommended by the subjective study of the behaviour of the chess players in relation to their physical environments, or the realization of body measurements in order to check and improve their performance.

Keywords: Chess game; Players luminous comfort; Illuminance; Shading devices; Numerical simulation.

I- Introduction :

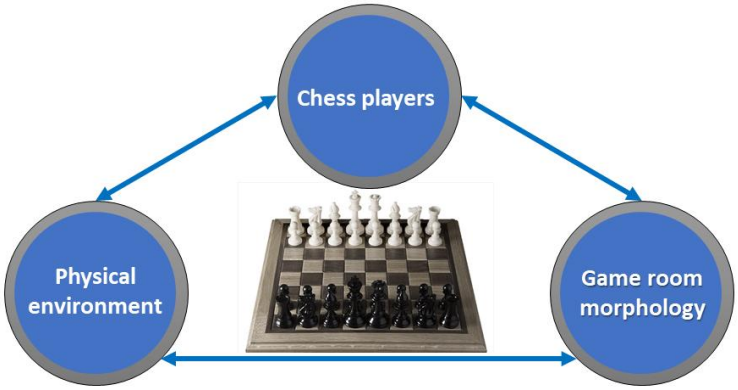
Chess is considered a well-known sports game (Parlebas 1974), which has a very long history (Hooper and Whyld 1996). The reason for considering chess as a sport is that it is based on competing against an opponent, a win-against-loser pattern (Blanch, Ayats, and Cornadó 2020). This cognitive sport is accessible to all social categories, where chess consists of universal rules that are simple and easy to learn, while they require the application of complex cognitive skills linked to slow and fast thinking (Grabner 2014; Blanch et al. 2017). In addition, the game of chess requires continuous production, proposals and solutions to problems in a creative way (Urra 2015). From this, chess is considered to be an intellectually demanding sport (Blanch et al. 2020), knowing that it is also considered to be a physically demanding sport, where players have to maintain concentration during a chess competition (Gentile, Boca, and Giammusso 2018). Chess is often thought of as mental boxing (Ruiz and Luciano 2012), where the cardiovascular activity and other physiological cues of chess players are similar to those of people who play sports involving more physical activity (Kriz, Vokal, and Krizova 1990), because, in this game, a single mistake can cause a quick defeat (Ruiz and Luciano 2012).

In the educational field, chess competitions are designated for different age categories (primary, middle, secondary and university level), where they allow players to learn determination, motivation and sportsmanship; and it also contributes to the intellectual development of players, social integration and the reduction of the crime rate (Belva, Bielik, and Gillet 2014). In scientific literature researchers draw lessons from the game of chess concerning the regulation of cognitive improvement in education and the professions (Mihailov and Savulescu 2018), where the importance of the game of chess lies in its being provides a model task environment for the study

of basic cognitive processes, such as perception, memory and problem solving (Charness 1992). The game of chess attracts the attention of many researchers, where it has been studied in detail in the literature, mainly in psychology (Helsen et al. 2016). It is also considered as an important research area in the study of expertise (Gobet, Retschitzki, and de Voogt 2004; Gobet and Campitelli 2007). In contrast, although the field of action of this sport spreads out enormously in a few years (Urra 2015), there is a remarkable lack of scientific literature which studies the behaviour and the comfort of the players of chess game of North Africa.

In Algeria, chess competitions are generally held in indoor spaces, such as sports halls, where there is a relationship between the chess player (the occupant), the environment (indoor and outdoor) and the game room (the architectural space), as shown in Figure 1. During these competitions, the players or the organizers of chess games constantly seek to ensure or improve the luminous comfort of the game rooms. using artificial lighting. This leads to an increase in electricity consumption, where the search for comfort is not really free, because changing the ambient conditions according to our amenities (Roditi 2011), forces us to consume energy (Jannot and Djiako 1994). But, the problem is not purely energy consumption, because it is also a problem of comfort.

Figure (1): Relationship between the chess players, the environment, and the game room



The thermal, light and acoustic comfort of the players is very important for this type of sport, where the players cannot achieve maximum concentration in an uncomfortable environment. Because the level of comfort affects the physical, physiological and psychological side of the occupants. Like the indoor environment parameters, the level of comfort of the players (occupants) thus depends on several urban environmental, thermal, luminous and acoustic parameters outside (Bouzir, Zemmouri, and Berkouk 2017). Based on all of the above, this article aims to investigate the relationship between the luminous environment and the comfort of chess players.

According to the French Lighting Association, luminous comfort is a subjective impression of satisfaction of the visual system mainly provided by the absence of discomfort caused by the entire luminous environment. In addition, Narboni (2006) defined the concept as good viewing conditions, without glare. So, luminous comfort is a state of satisfaction of the body vis-à-vis the luminous environment depending on the quantity and quality of the lighting. In fact, the problem of player comfort is due to the almost total absence of specialized chess arcades, as this cognitive sport discipline is not considered a purely physical sport. Despite the existence of an Algerian Chess Federation (FADE), Algerian leaders neglect the sport of chess, and continue to develop only sports disciplines based on physical effort such as football, volleyball, handball, martial arts, athletics, swimming, tennis, cycling, boxing, rowing and sailing. Therefore, we cannot find specialized chess rooms in Algeria designed according to international standards to ensure the thermal, luminous and acoustic comfort of the players.

Based on all of the above, the main question for this research is:

- What are the most efficient architectural elements to improve the luminous comfort of the rooms used by chess players in the hot and arid climate of Algeria?

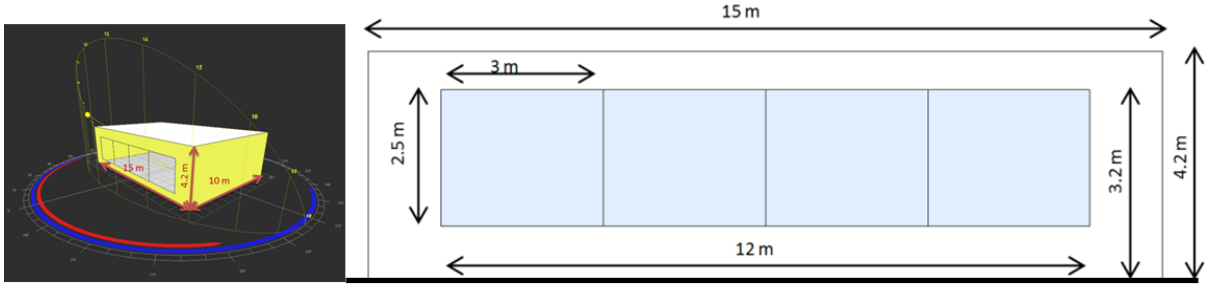
The main objective of this research is to objectively assess the impact of architectural devices on the lighting comfort of chess players. The idea is to propose a model which improves the luminous comfort of the rooms used by chess players in the city of Biskra which is characterized by a desert climate (Berkouk, Bouzir, and Mazouz 2018) with clear and sunny skies most of the year (Berkouk and Mazouz 2017).

II– Research methodology:

This research is based on the study of daylight illuminance (E) as an indicator in order to make an objective assessment of luminous comfort by using computer simulations by means of the Radiance software as the main tool of the research. Knowing that Autodesk Ecotect Analysis software was used for modeling 3D models, and the ArchiCad software for 2D modeling and was used for the calculation of luminous surfaces in (m^2). While, the SPSS software was used for the realization of the study statistics and the construction of graphs and histograms.

The glazed surface of each model (chess room) is 30m² with 12m length and 2.5m width. This surface consists of four windows 3m wide and 2.5m high, as shown in Figure 2. In fact, the type of glazing is an important parameter in the quality of lighting since it is a major intermediate between the outside and the inside. From this, we chose a clear glazing, which does not have a great impact on the quantity and quality of daylighting. Where, the gaming rooms have a type of clear photometry with a reflection coefficient of 33% for the floor and 67% for the wall and 70% for the ceiling.

Figure (2): Dimensions of the chess-room model: (a) 3D view; (b) South façade



For the analysis of the illuminance levels on the chess table that was made at 0.90m, it was necessary to analyze the virtual model of the game room without (WSD) and with the integration of the architectural components (shading devices) including: i) the standard horizontal overhang (SHO), ii) the horizontal louvers (HL), iii) and the Light-Shelf (LS). To have an optimal level of illuminance to assure a luminous comfort in a game room of chess. Figure 3 shows the models of chess rooms in 3D, while Figure 4 shows the Radiance software outputs for the model called (WSD), (SHO), (HL) and (LS).

Figure (3): Models simulated, south facing: (a) Without Shading Devices; (b) Standard Horizontal Overhang; (c) Horizontal Louvers; (d) Light-Shelf

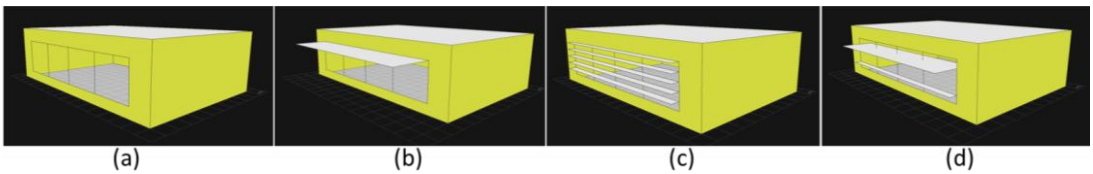
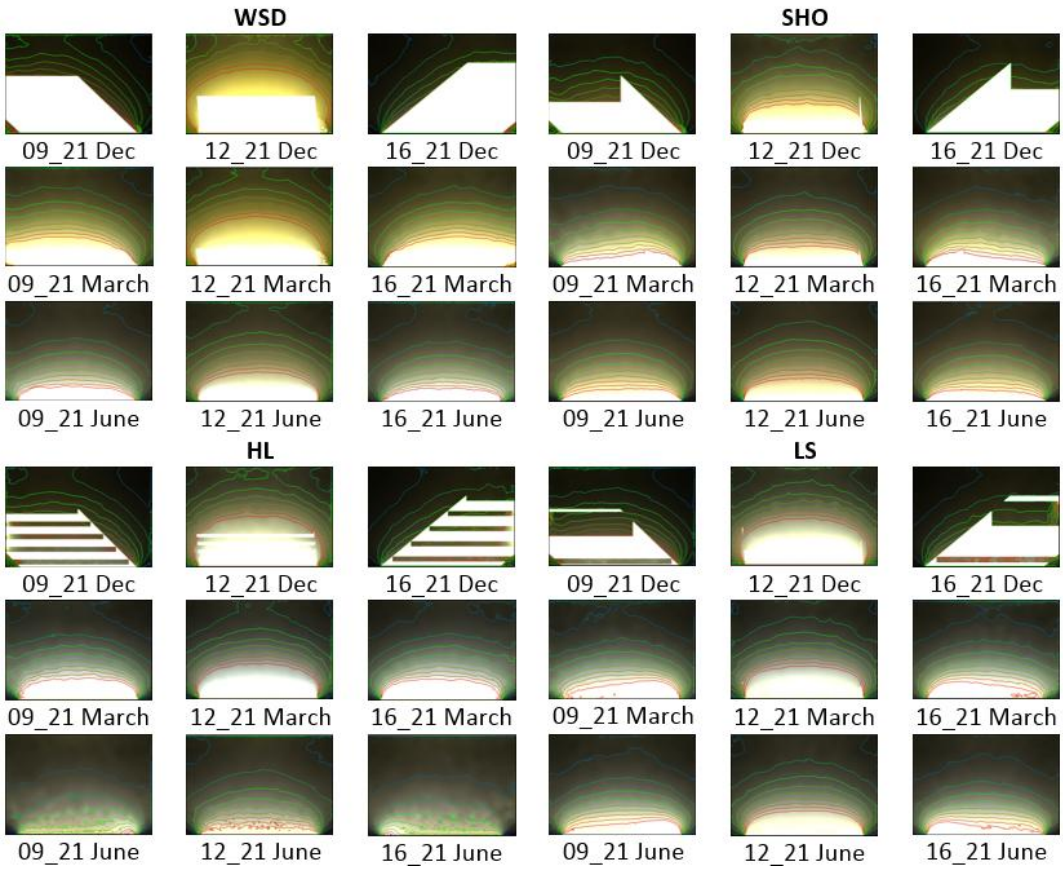


Figure (4): Radiance outputs for the models (WSD), (SHO), (HL) and (LS)



In order to judge the players luminous comfort, we have based on the following scale of classification of lighting in the game room: i) very comfortable (300lux <E <850lux); ii) comfortable (200lux <E <300lux) or (850lux <E <200lux); iii) uncomfortable (E <200lux) or (E> 2000lux). From this, Figure 5 represent the scale of judgment used in this research.

Figure (5): Classification scale of illuminance

III- Results and discussion :

III.1. Evaluation per month

Figures 6, 7, 8 show the average horizontal illuminance level surfaces that fell on the chess game table for each model over the three annual days, 21st December, 21st March and 21st June, respectively.

From the reading of Figure 6, it is observed that the model without any protection (WSD) makes the luminous environment the most uncomfortable for the players, with an average surface of 45.85m^2, which causes an indirect glare to the players. It is due to a high quantity of light, upper to 2000 luxe at the level of the table of the game. While, the SHO model, is characterized in this winter period by a glare average surface that touches the 28.13m^2, with a standard deviation that arrives at 6.30m^2. At this level, the (HL) model makes an average area of 34.63m^2, which can be described as a glare luminous surface during this time of the year, with a very low standard deviation that touches only 1.68m^2. This is due to the almost total concealment of solar radiation by this architectural device. Similarly, it is observed that the Light-Shelf (LS) renders an average surface area of 29.58m^2 with a standard deviation of 5.32m^2, which causes glare to the players by lighting greater than 2000 lux during this winter period.

In the reading of the zone very comfortable to the players (2000> E> 947), we note from Figure 6 that the model without any protection (WSD) has an average surface too high during this period which touches the 20.32m^2 with a very standard deviation important that touches the 16.67m^2. While the surfaces 13.04m^2, 20.20m^2 and 19.31m^2 present respectively the average surfaces the very comfortable to the players during the winter period, concerning the models occulted with SHO, HL and LS.

Figure 6 also shows that the values 4.22m^2, 8.94m^2, 6.74m^2 and 7.78m^2 respectively present the average surface area of the game comfortable to chess players (316> E> 105) during the winter period, concerning the WSD, SHO, HL and LS models. On the other hand, Figure 6 shows that all models studied do not cause uncomfortable playing areas to players due to the drop in the amount of natural light (105> E) during this winter period.

Figure (6): Average area of comfort zones according to each shading device (21st December)

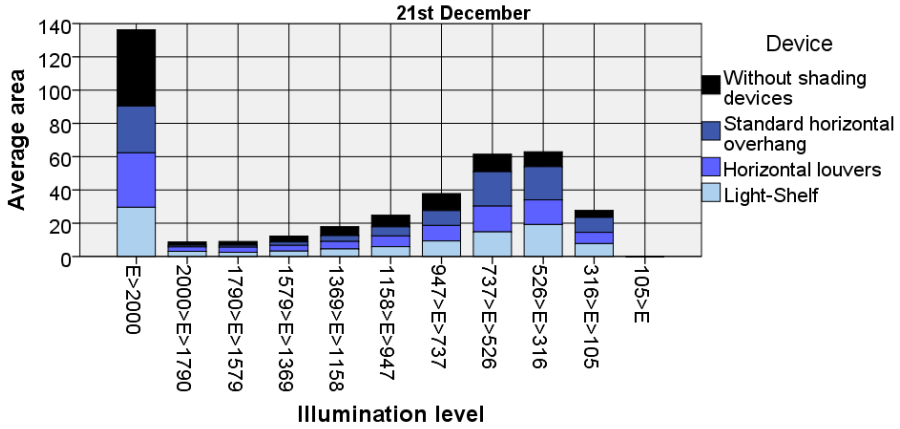


Figure 7 shows that the model without any protection (WSD) is characterized in the spring period by average areas that affect the 27.44m^2, 25.46m^2, 43.84m^2, 3.14m^2 and 0.00m^2, respectively. For the uncomfortable area due to the excessive amount of natural light (E> 2000), the comfortable zone (2000> E> 947), the very comfortable zone (947> E> 316), the players comfortable zone (316> E> 105) and the uncomfortable area due to the low amount of natural light (105> E).

On the other hand, we notice slight discrepancies between the luminous surfaces that characterize the different models concerning the different comfort zones of the players. Where, the models occulted by a WSD, SHO, HL and LS models are respectively characterized by surfaces of 10.03m^2, 17.79m^2 and 14.18m^2 concerning the uncomfortable areas that cause an indirect glare to

the players, because the illuminance in this case is greater than 2000 lux. They are also characterized by the 18.21m^2, 21.83m^2 and 21.24m^2 surfaces for the comfortable area for chess players (2000> E> 947). And by the surfaces 50.53m^2, 50.70m^2 and 39.51m^2 for very comfortable areas to the players (947> E> 316). In addition, they are characterized by the surfaces 21.13m^2, 9.69m^2 and 16.26m^2 for the comfortable area (316> E> 105) in order to perform their visual tasks naturally (chess game) without the use of artificial lighting.

Figure (7): Average area of comfort zones according to each shading device (21st March)

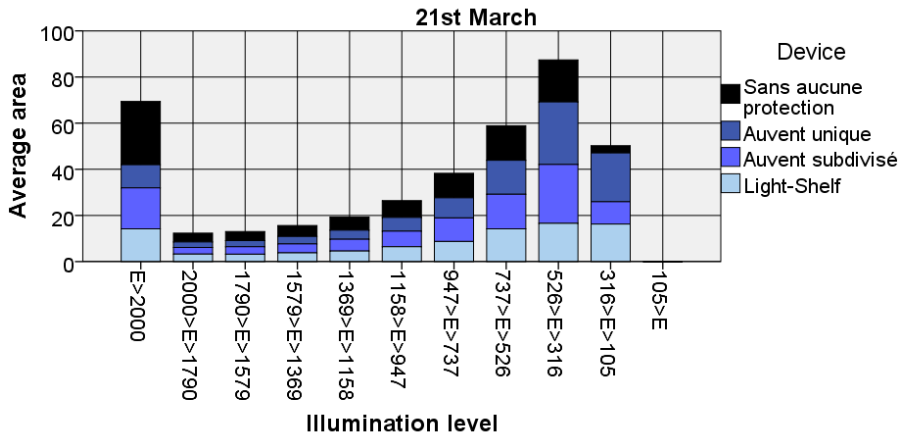
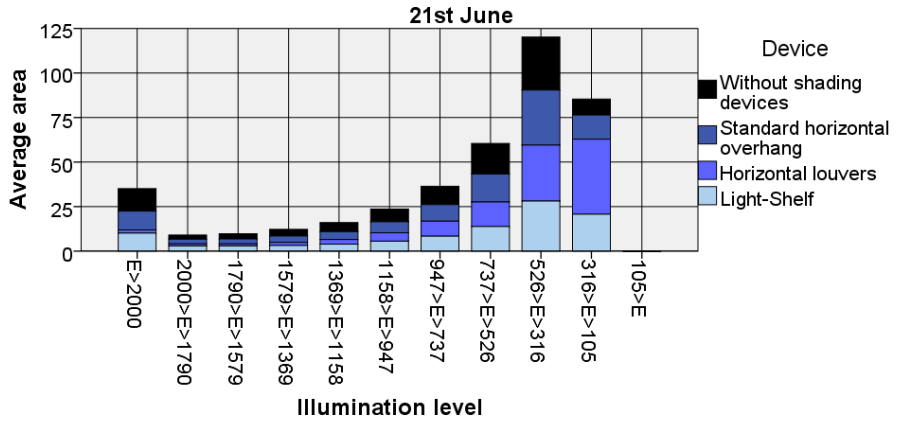


Figure 8 shows that the model obscured by a HL models records the lowest value for the uncomfortable area due to too high light which causes indirect glare of the players during the summer period by an average surface area that reaches only 1.82m^2, with a standard deviation that affects the 2.98m^2. While the maximum value that has been recorded for this uncomfortable area during this period is in the results of the WSD model, with an average surface that touches the 12.61m^2 with a very large standard deviation that reaches 6.29m^2. The two other models have very similar values in this zone uncomfortable to the players during this summer period, with a surface of 10.54m^2 in the SHO model, and 10.11m^2 in the LS model.

Figure (8): Average area of comfort zones according to each shading device (21st June)



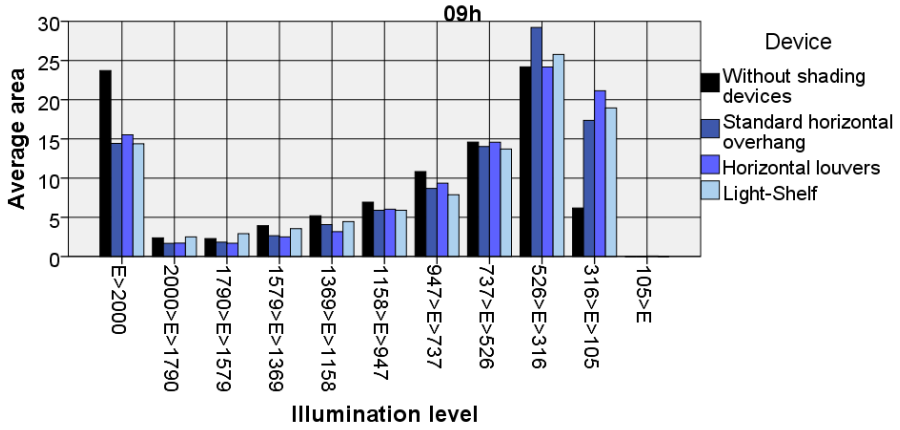
From all the above, we can deduce that the architectural devices studied are more efficient during the summer period. Where, they reduce the uncomfortable surfaces due to the very high light that causes an indirect glare to the players through the game spaces. Because the shading devices break the sun rays which are not horizontal, because the sun is in basket height in the summer period. From this, the players can make the visual tasks naturally without the use of artificial lighting.

III.2. Hourly evaluation

Figures 9, 10, 11 show the average horizontal illuminance levels that fell on the table game of chess players according to each model during the three hours of the day, 9h, 12h and 16h, respectively.

Figure 9 shows the luminous efficiency of the various architectural devices, in order to make the optimal luminous environment to the players during this time 9h throughout the year. Where, the comfortable surfaces to the players are very close, concerning these different devices. Where, the average areas of 85.42m^2, 84.34m^2 and 85.60m^2 are recorded at the models occulted by SHO, HL and LS, respectively. While, the WSD model gives a comfortable annual surface to the chess players who touches the 75.61m^2 in this hour (9h). In addition, Figure 9 indicates that the average annual area of 23.72m^2 with a standard deviation of 15.54m^2 of the WSD model without at 9 o'clock is an uncomfortable surface that causes an indirect glare to the players. Where, the illuminance level is greater than 2000 lux. Besides, this figure shows that 14.43m^2, 15.52m^2 and 14.39m^2 of annual surfaces of the models with a SHO, HL and LS.

Figure (9): Average annual surface of the comfort zone according to each shading device (at 09h)



From the results shown in Figure 10, we find a slight discrepancy between the different results of each model. Where, 62.83m^2, 81.93m^2, 77.2m^2 and 66.24m^2 of WSD, SHO, HL and LS models, respectively are comfortable annual average surfaces to the players, with a presence of an illuminance level, which varies between 105 lux and 2000 lux at 12 o'clock. While, only 37.16m^2, 17.62m^2, 21.67m^2 and 24.92m^2 of the studied models respectively, are surfaces that cause an indirect glare to the players during this time of the day (12h) throughout the year.

Figure (10): Average annual surface of the comfort zone according to each shading device (at 12h)

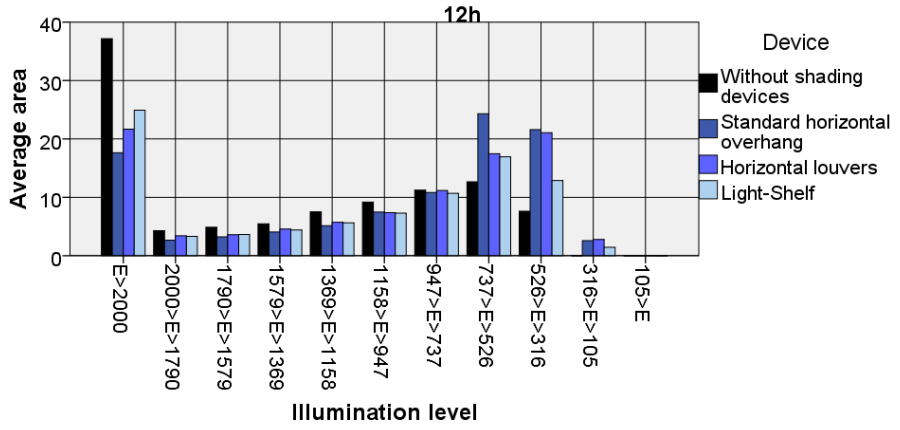
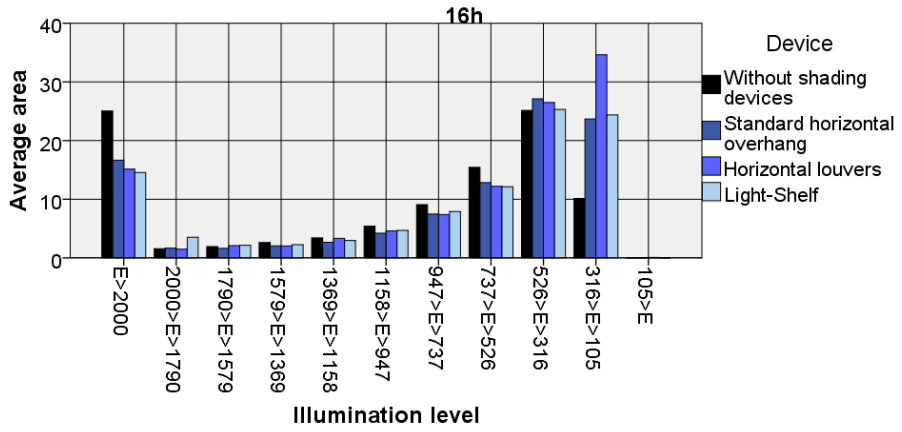


Figure 11 shows that 74.73m^2, 83.34m^2, 94.25m^2 and 85.30m^2, WSD, SHO, HL and LS models, respectively, are comfortable annual average surfaces with an illuminance that varies between 105 lux and 2000 lux which makes the optimal luminous environment to chess players in the indoor space at 16h. Figure 11 also indicates that only 25.03m^2, 16.65m^2, 15.14m^2 and 14.56m^2 of the models studied are uncomfortable annual average surfaces for chess players who play at 4pm. Knowing that this uncomfortable feeling of the players is due to the too high daylighting, which falls on the table game by an illuminance upper to 2000 lux.

Figure (11): Average annual surface of the comfort zone according to each shading device (at 16h)

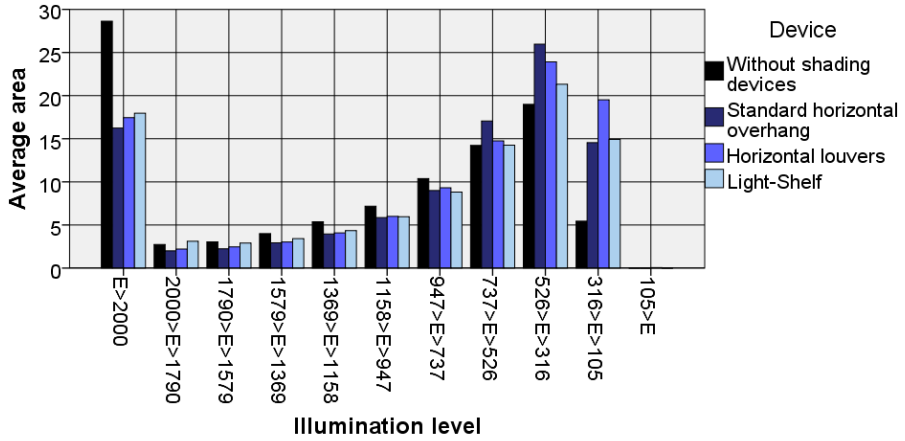


From all of the foregoing, we can deduce that architectural features make the optimal luminous environment to the chess players. On the other hand, we can deduce as well as the Light-Shelf model makes the best luminous environment at 9am. While the SHO model makes the optimum light environment at 12 o'clock. While the HL model makes the best luminous environment at 4pm all year round.

III.3. Comparison of results

From the reading of the Figures 12 and 13, we notice that there is an increase in the annual percentage of 23% of the surface that causes indirect glare on the table of the game. Because the illuminance level upper than 2000 lux in the chess room that has a window without any protection (WSD) compared to other models that have an almost equal percentage of 14% to 15% of surfaces that causes indirect glare in these game rooms. This is due to the impact of the different sun protections that the SHO, HL and LS.

Figure (12): The average area of comfort zones according to each device

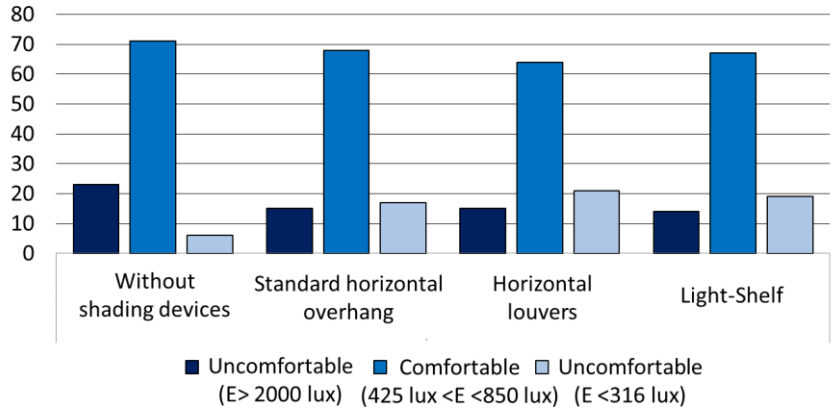


In addition, it is observed that the annual percentage of the comfortable surface is higher in the chess room, which has a window without any protection and the lowest annual percentage of the surface, which can be described as a low dark surface in the same room of the game. All this due to the penetration of direct sunlight during the daytime hours that result in a high illuminance level of the indoor luminous environment.

Despite the good results from this chess room compared to the other rooms in the comfortable zone level which has a percentage of 71% and the area slightly dark with an annual percentage of 6% of the total area. This room is the worst at the indoor luminous comfort level, because this room at the highest annual percentage of the surface that causes an indirect glare.

Then, we also observe that the best model in the three remaining rooms is the room which has a window equipped with a standard horizontal overhang (SHO). Because it has the highest annual percentage for the three models of 68% of the player's comfortable surface and the annual percentage the least for the three models of 17%.

Figure (13): Luminous comfort Level according to the shading devices



The model that follows the latter is the game room that has a window equipped with a Light-Shelf (LS). Because has an annual percentage of 14% of the surface that causes a glare to the players that is less percentage of the game room that has a window equipped with a horizontal louvers (SL). The latter is with a percentage of 15%, and the annual percentage of the highest player's comfortable surface, which is equal to 64% of the total surface and the not very dark surface in the game room equipped with a LS is less than the annual percentage of the game room equipped with a HL.

For the choice of the best architectural feature of the chess-room window with South orientation, we can choose the Light-Shelf. Because it is easy to achieve compared to the standard horizontal overhang that has a range of 2.68m compared to the aesthetic side.

IV- Conclusion:

This study is based on the numerical simulation which was carried out using "Radiance" and "Autodesk Ecotect Analysis" software to evaluate the level of luminous comfort of chess players in four virtual models equipped with different shading devices. The findings from this study suggest that the presence of shading devices in the openings of chess rooms plays an important role in improving the behaviour of players, where they can perform their visual tasks naturally without resorting to artificial lighting. The results also show that the studied shading devices are more effective during the summer period, where they reduce the uncomfortable surfaces resulting from the very strong light which causes indirect glare for the players through the playing spaces (the table game). This research also highlights that architectural devices can provide a comfortable luminous environment for chess players at different times of the day, where it can be noted that the best shading device for a south-facing chess room window is the Light-Shelf.

The strength of this research lies mainly in its approach, which is mainly based on digital simulation to assess the level of comfort of chess players in the city of Biskra, and for its proposal for an architectural device to improve the efficiency of these rooms in terms of light comfort. In the field of sports or architecture, none of the previously published research has investigated the comfort or behaviour of chess players in closed rooms of the north of Africa. The results of this research are limited to the evaluation of the luminous efficiency of the chess halls of the city of Biskra, based on a single virtual model facing south with predetermined dimensions.

Based on our results, the authors advise Algerian policy makers to give importance to this cognitive discipline. Another interesting implication of this study is that it calls on the leaders of the Algerian Chess Federation (FADE) to engage with decision-makers to adopt and apply the results and recommendations of this study to build sports halls for the game of chess to ensure the performance of players.

Other parameters must be taken into account to improve the comfort level of chess players, such as table positioning, player orientation, clothing, and diet. On the other hand, the authors are aware that this study opens an important area for future research in the field of sport in Algeria which should focus on the subjective study of players, or the realization of bodily measures in order to check and improve their performance.

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