THEMES OF WELLBEING ASSOCIATED WITH DAYLIGHTING PRACTICE AND SHADING SYSTEMS IN WORKING ENVIRONMENT

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Abstract: Daylighting conditions throughout an internal space directly impact building occupant health and wellbeing. Various physiological and psychological benefits have been attributed to the presence of daylight in buildings. In order to enhance the performance of building facades, shading systems are considered as one of the most preferred methods. Shading advantages are limited to protecting a building facade from direct sunlight issues and controlling the amount of natural light in a space. The primary focus of daylighting design recommendations is improving energy efficiency rather than enhancing health and wellbeing. While some of the biological influences associated with the amount of daylight received by building occupants and its impact on their stress, level of productivity, and sleep quality are well documented, there is a general ambiguity in the literature about measuring occupant wellbeing related to daylighting design. Many studies relied on assessing daylight exposure as an indicator to measure users' health and well-being directly. Other studies measure visual comfort resulting from having enough contrast in daylighting Illuminance as a way to quantify wellbeing. This paper aims to define themes of wellbeing related to daylight design founded in related studies referring to the role of shading systems to improve daylight inside the working environment. This paper is structured into three sections; the first section aims to provide background information to those who are not deeply involved in the topic through a review of what wellbeing means in theories and why work and wellbeing are important. The second section is a critical review of 12 related studies using a thematic analysis method to extract the approaches used to quantify wellbeing related to daylighting and shading systems. The final section provides a summary of the article, highlights the main knowledge contributions, and provides future research recommendations. The findings illustrate the gaps found in wellbeing assessment tools and the needs to establish a holistic approach consisting of three factors: daylight, outside view, and shading systems.

Keywords: daylighting, health and wellbeing, shading systems, working environment.

1- Introduction

The World Health Organization (WHO) has indicated that employees' wellbeing must be a priority for solving mental health problems. Many studies show that one in four people have significant mental health issues from workplace disability (World Health Organisation, 2022; Valente, 2010; NAMI, 2022). Every year European Union spends over 135 Euros on Occupants' mental health problems (Carolyn et al., 2011), the United States spends between $150 and $300 billion per year (American Psychological Association Stress, 2013), and Canada spends around $50 billion each year (Mental Health Commission of Canada, 2022). Furthermore, in the UK, work stresses, depression, and anxiety accounted for more than 600 people in their working environment and the average sick days per person was 21 days; moreover, wellbeing illnesses such as depression and stress affect more than 40 % of employees in the UK (Gill et al., 2020). Daylight inside a building has associated with many physiological and psychological benefits that affect occupant wellbeing. Daylight conditions throughout an indoor environment directly impact building occupant health and wellbeing (Dobrica et al., 2020; Owl Labs, 2021; E, K. Kelloway et al., 2021; National Standard of Canada, 2013; Zhou, P et al., 2020). Although light is predominantly perceived as a visual phenomenon, it also affects human physiology, Behaviour, and Mood, summarized as non-visual effects (International Commission on Illumination 218, 2008). Daylight visual effects refer to the photometric measurements used to analyze how much light is present in a given space for tasks. In contrast, non-visual effects are subjective assessments that evaluate how the light is perceived (colour, intensity, distribution, uniformity, etc.)

The façade is a central element to compromise between the inner space comfort's requirements and the dynamic external environment's parameters. Some working spaces stimulate occupants' wellbeing and feelings of happiness, visual interest, and excitement. In addition, installing a shading system to the façade could lead to have better daylight quality. Shading advantages are not only limited to protecting a building facade from being directly exposed to sunlight (C, Ticleanu et al., 2121; A, Couvelas1, et al., 2018) but also controlling the amount of daylight in a space. Shading systems are considered as one of the most preferred methods to enhance the performance of building (Ayca, Kirimtat et al ., 2016). In contrast, other facades stimulate disturbance, gloom, and discomfort depending on the daylighting condition, which could be optimized using shading systems. However, Klein presents a classification of façade systems based on stating recent and future functions. However, there was no reference to a façade system in response to health and wellbeing achievements (Tillmann Klein, 2021).

For the past 40 years, daylighting visual effects have been assessed and measured using a variety of daylight metrics. However, recommended practices in daylighting design are primarily focused on improving energy efficiency and building occupant comfort rather than optimizing its role in enhancing the health and well-being of users (Elkadi, H. Al-Maiyah, S. 2021). Several studies have examined the relationship between daylight and wellbeing for the workplace and indicate the challenges that come with balancing competing environmental goals for indoor environments. To provide an overview of the current state of research in this topic, a literature review of specialist academic journals was conducted over the last two decades and understanding the limits of the methods used to assess daylighting, non-visual effects, and wellbeing as well as the practical implications of this knowledge. The paper begins with historical background about the definition of Wellbeing and the themes associated with Daylighting quality. A summary of the literature is followed by a summary of the findings, these findings are organized under three subheadings based on the trends identified, the study focus, methods, and wellbeing themes.

2- Wellbeing and Daylighting in architectural practice.

The concept of wellbeing refers to what is intrinsically valuable to an individual. It consists of two dimensions on both a personal and social level that explain how individuals feel and function (Crisp Roger, 2020). The wellbeing of a person is ultimately good for this person, which is in this person's self-interest (Frank, M et al., 1982). In another definition, wellbeing is "a special case of attitude" (Koen Steemers, 2021) consisting of two key elements: feeling good and functioning well (Guy Fletcher, 2016). Theories of wellbeing aim to clarify which state features are responsible for a person's wellbeing. Hedonistic theories equate wellbeing with the balance of pleasure over pain. Desire theories state that wellbeing consists of desire-satisfaction: the higher the number of satisfied desires, the higher the wellbeing. Objective list theories state that a person's wellbeing depends on a list of factors that may include both subjective and objective elements (Mark Stanley Rea et al., 2005).

To explain the relationship between daylighting and wellbeing in the lighting community, a philosophical shift occurred to define the new knowledge related to Architectural practice (Newsham, G et al, 2010).

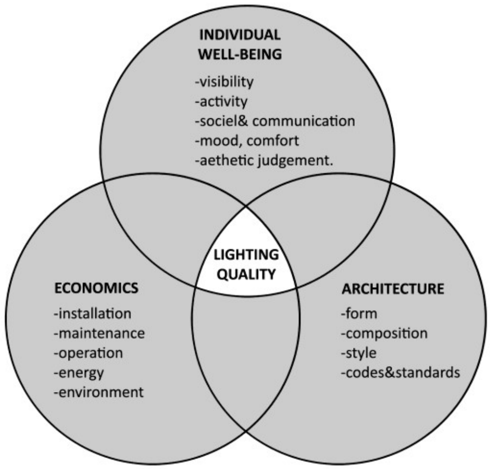


Figure 1: Vetich model. Newsham, G. R, Cetegen. D, Veitch. J. A. Whitehead, L. A., (2010).

One of the prior clarifications concluded by Veitch, who illustrated a model based on the objective list theory of wellbeing, states that a person's well-being depends on a list of factors such as mood and comfort. Furthermore, according to architecture practice, Veitch (Mark Stanley Rea et al., 2005) identifies four factors to integrate with lighting quality. These factors are form, composition, style and codes, and standards regulation (Fig. 1).
In the past 40 years, several Daylight standards have been published to outline ideal environmental parameters for workplace environments, such as Daylighting, Energy consumption, Thermal Comfort, Visual Comfort, etc. This paper is limited to daylighting; therefore, the working environment in terms of daylight has two targets to be achieved, the quality of daylight in the space and the quantity of task illuminance recommended by daylighting standards. Furthermore, recommended standards in daylighting design are primarily focused on improving energy efficiency and thermal comfort rather than on optimizing its role in enhancing the health and wellbeing of users. One of the most critical aspects or additions in current building standards is introducing the WELL BUILDING STANDARD, which states new metrics related to occupant health and Wellbeing. WELLv2 Building Standards are much more comprehensive than sustainability rating systems. They address nearly all health-related indoor environmental concerns cited in academic research (Newsham, G et al, 2010). These metrics could be achieved by controlling daylight conditions through a façade design (JJ, McArthur.& Colin, Powell, 2020;The WELL Building Standard, 2021). WELLv2 recommended that the Occupant's ability to interact with the outside view through windows has been linked to psychological advantages such as daylight. This connection can improve occupant comfort and Wellbeing because the availability to interact with the beneficial direct sunlight and view of the outside environment will reduce stress and improve worker performance (C, Schweizer et al., 2007).

3- Methodology

3-1 Search process

The paper presents a deep analysis to identify the most relevant publications related to daylighting, Health, Wellbeing, and shading systems over the last ten years. Numerous databases are widely available online, and the most prominent sources such as SCOPUS, Web of Science and Google Scholar were used. The literature was chosen after systematically searching Google Scholar and SCOPUS for recent daylighting-related articles. The research was limited to journal papers, and the combinations of the following keywords were used: Daylight, Health, and Wellbeing. Only articles exploring daylighting effects on Occupant Wellbeing were selected to form the paper sample. Hence, the following were excluded: studies analyzing daylight comfort in terms of specific points such as thermal consumption, energy, and artificial light, unless they refer to the interaction of occupant comfort and Wellbeing. The criteria matched with 12 published papers in essential Daylight, Shading, and Wellbeing.

Table 1: Search terms In 'Scopus' and 'Google Scholar'(Author's own)

	Search items
Scopus & Google Scholar	- (**Daylight** and **Wellbeing** and **View** and **Shading**(Title/Abstract) AND daylight, natural light (Title/Abstract)) NOT Thermal (All Fields) - (**Daylight** and **Wellbeing** and **View** and **Shading** (Title/Abstract) AND daylight, natural light (Title/Abstract)) NOT Thermal (Engineering filed)

3-2 Data extraction

The following data were extracted from the studies if available: (1) Research information including name and year of publishing (2) Focus of study (i.e., wellbeing, comfort, health, and people's perception of the ambient conditions of natural light, quality of view); (3) Characteristic element; (4) Daylight metrics; (5) Themes of wellbeing. A table gathering all these data was reviewed.

Table 2: Data extraction in one table (Author's own)

Table section				
1	2	3	4	5
Research Info.	Methods	Characteristic element	Daylight metrics	Themes of wellbeing
12 paper	3 methods	12 sample	4 metrics	4 themes

4- Themes of Wellbeing in daylighting studies

Prof. Berson from Brown University discovered intrinsically photosensitive retinal ganglion cells (ipRGCs) in 2002, which led to an increased interest in the non-visual effects of light. Several experiments have been performed to assess the impact of non-visual responses on different daylighting conditions, such as melatonin suppression, sleep quality, subjective and objective visual interest, and Mood (Thapan, K, 2001; Brainard, GC, 2001; David M Berson , 2002; P, Khademagha etal., 2016). These experimental studies will help to understand non-visual effects and provide guidelines for daylighting designs and systems that positively impact human health and Well-being. Experiments in laboratories have revealed the light factors that influence non-visual effects. The International Commission released a technical report on healthy interior daylighting recommendations on Illumination (CIE) in 2016 that provided researchers with a research roadmap (Fig. 2), (International Commission on Illumination, 2016). To understand how light exposure influences its effects, define non-visual effects. A healthy and comforting daylighting environment consists of three main components: circadian rhythm, visual interest, and mood (Hui, XiaoHuiling & CaiXuefeng Li, 2021).

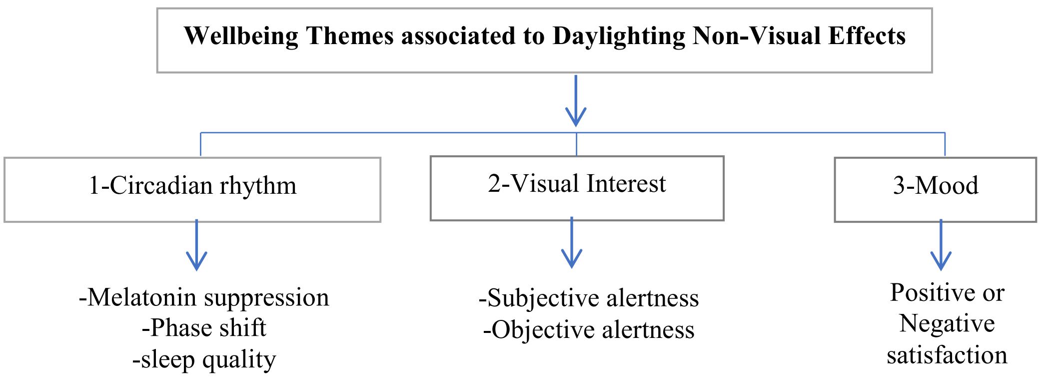


Figure 2: Daylight Non-Visual effects parameters. ((International Commission on Illumination, 2016)

Based on these parameters, the selected samples present four themes of wellbeing associated with daylighting non-visual effects as follows: 1-Circadian rhythm (Ignacio, Acosta, 2019; Mohamed, Boubekri et al., 2020), 2-Visual interests and impressions (Maria, L. Amundadottir, 2017), 3-Satisfaction with access to the outside view content (Ihab, M. K, Elzeyadi, 2011), view access (Anja, Jamrozika et al., 2019; Mohamed, Boubekri et al, 2020), and daylight quality (Ahmed, Sherif, 2015).

4-1 **Circadian rhythm**

Some studies is focusing on how better daylight conditions can improve human health and Wellbeing by improving occupants human Biological clock, which affects their circadian stimulus (Ignacio, Acosta, 2019; Mohamed, Boubekri et al., 2020). Ignacio discussed the minimum Window-to-Wall-Ratio effects on the colour temperature in a classroom. In this study, circadian stimulus autonomy was measured as the percentage of days per year that circadian stimulus exceeds a threshold in a classroom. However, natural and electrical light can improve circadian stimulus. The experiment occurred in a classroom with a large window of variable sizes of 30%, 45%, and 60% with different positions and orientations. In addition, the results from three typical sky conditions. Making a comparison of the Circadian stimulus values for the three window sizes reveals that; in comparison with the medium-size window, when the percentage of the window to the facade is 60%, it shows an average increase in Circadian stimulus of about 15 %, While the window to façade ratio score 45%, there is an increase of 14 % over the small window. This approach could be helpful to show how window design parameters and daylight conditions can improve occupant wellbeing. In another study, Mohamed Boubekri (Mohamed, Boubekri et al., 2020) illustrates the advantages of daylight exposure and the clear view of the outside environment. Boubekri linked daylight exposure impact to circadian rhythm effects, which can impact occupant well-being, improving sleep quality and productivity in working space.

4-2 **Visual interests impressions**

Daylighting visual effects are quantitative studies by measuring daylighting metrics such as Daylight factor, Glare, Luminance distribution, and daylight autonomy in a given space for task performance. While Daylighting non-visual effects are qualitative studies aiming to explain the health and wellbeing themes such as circadian rhythm, visual interest, and mood on occupant's satisfaction, impressions, and cognition. Maria Amundadottir (Maria, L. Amundadottir, 2017) introduces a new approach for improving occupant wellbeing in space by recording their visual interest behavior. This new approach considers that field of view received at occupant eye level plays an essential factor in occupant perception of daylight conditions. Amundadottir conducted an experiment using Visual Reality to assess three factors: non-visual health aspects and visual interest and gaze motion. Comparing the results between each factor illustrates how humans respond to daylight in a space. This experiment was implemented in a controlled laboratory where gaze movements were scored using an immersive spatial approach. The results show that daylight distribution has a variable effect on non-visual health aspects and visual interest.

4-3 **Satisfaction with view and daylight quality**

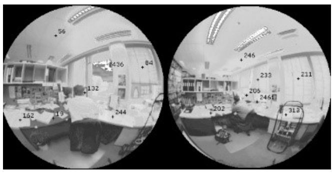
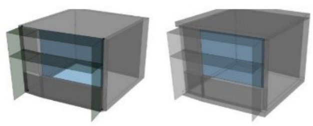
Another type of research aimed to investigate the ability of shading systems with non-visual effects (Sergio, Altomonte, 2009; Ihab, M. K, Elzeyadi, 2011;Ahmed, Sherif, 2015). The shading parameters became dependent parameters, aiming to improve occupant comfort and

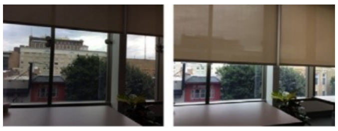
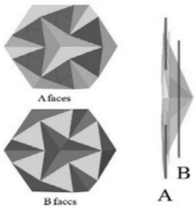
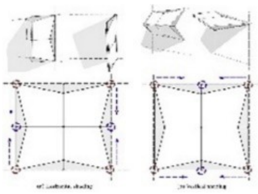
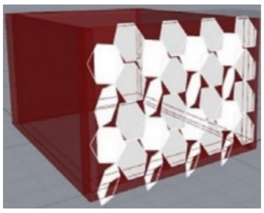
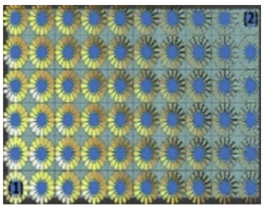
Wellbeing by improving daylighting visual comfort aspects such as glare and distribution and occupant perception of the outside view quality that will enhance his Mood, perception, and Wellbeing. The complexity of this type of research that connects quantitative and qualitative measurements is still needed for further investigation. Sergio Altomote (Sergio, Altomonte, 2009).researched to define the impact of using such a blind as a shading device to improve occupant perception towards daylight conditions in a workspace. This impact aims to assess human perception and Wellbeing by defining a framework showing some recommendations on which type of blind configuration will be related to the type of work. Sergio implemented an experimental study using a sample blind as a shading device in a workspace. The experiment was conducted in two seasons, winter and summer, at 10 am with a fixed orientation to the east. In the winter, however, glare issues are coming from the low of the sun angle. However, it was observed that occupants prefer to do paperwork tasks than screen tasks during the morning period. Their perception of daylight provision and view out make them feel better and increase their activity. Sergio also tested two situations of this blind to assess the Luminance ratio and colour temperature as the most critical indicator that affects occupant perception in a workspace.

Subsequently, the importance of context impact and outside view composition became dependent parameters in investigating the ability of daylight non-visual effects. Elzeyadi (Ihab, M. K, Elzeyadi, 2011) conducted a study to quantify how daylight conditions and outside view quality could affect employees' health and Wellbeing. To illustrate this effect, the author relies on the Biophilic approach to show the relationship between natural outside view and daylight and their impacts on sick leave for employees. Elzeyadi used different pictures from different locations and ninety-eight full-time employees to assess outside view quality. The employees were asked to rank some selected 12 photographic images of different outside views surrounding the working area. After that, a questionnaire was conducted to know what employees preferred to see while sitting in offices on campus that ranged from the forest, urban, and street view scenes. In addition, Elzeyadi made a daylight analysis using HDR images taken from the setpoint for each employee to define the glare issues associated with the outside view. Elzeyadi conducts qualitative multiple sorting techniques following an interview with the participants to connect the sick leave ratio with the outside view content. Participants were asked to rank the outside view scenes. Elzeyadi argued that the highest ratio of employee sick leave was scored in the workspaces with a natural outside view such as a forest or urban greenery scenes. Hellinga (Hester, Hellinga. & Truus, Hordijk, 2014). developed a new method to describe the relationship between Daylight and the View to the outside through a window in space. This method is based on showing the view through a window to the outside environment using the 180_ equidistant projection technique. Furthermore, the author used the luminance ratio to quantify the daylighting level inside the space. The mean value of the Luminance ratio to the working area should be not more than 1:10, and concerning the background of the working area, which is called the Inner Field of Vision, should be 1:30 to avoid visual discomfort. According to this study's assessment of view quality, a questionnaire was implemented by asking participants to rank 23 pictures taken in different outside view environments.

Regarding the ability of shading systems to integrate with non-visual effects and the outside environment, shading systems parameters became dependent values to control what daylighting brought internally and assess occupant wellbeing to the outside view quality. Anja Jamrozik (Anja, Jamrozika et al., 2019) conducted an experiment using two shading devices- Dynamic Tint and Motorized mesh shades- for the window of the working space. These devices aim to present the impact of different daylight themes and views on the outside environment on occupant satisfaction. Although having a window in the working space has many advantages, Occupants may suffer from glare. Therefore the author implements an actual experiment in a working space using two types of shading devices. The first type of shade is manual-automated control shading. The second one used material advantages for the tinting glass as a shading device. This experiment aimed to reach the optimal values to achieve the appropriate amount of daylight in a workspace and view outside with minimizing glare issues. The author concluded no significant differences resulting from using Dynamic Tint or Motorized mesh shades based on occupant perception. This study demonstrates how different shading systems can improve occupant well-being by improving performance and reducing eye strain in office environments by providing access to daylight and views. Mohamed Boubekri (Mohamed, Boubekri et al., 2020) implements an experiment using two different shading systems in two office environments. The first room has an Electrochromic glass that acts as a shading device. The other room uses a Traditional blind. To measure sleep quality improvement, Boukebri used a wrist-worn actigraph device, which contained a light sensor that measures light exposure (lux) at the wrists of each participant and the duration of time asleep. This experiment concluded that achieving an optimized daylight and views condition can improve occupant wellbeing by increasing sleep time to 37 min longer. The review also finds a different approach to improving occupant health and Well-being by simultaneously focusing on achieving better daylight conditions and outside view quality. This approach is based on a verbal questionnaire to occupants to rank different outside view scenes based on their feeling.

Table 3: Themes of wellbeing identified across the sample (Author's own)

Assessing non-visual effects					
No	**Studies**	**Methods**	**Shading potential (Found/ Not found)**	**Daylight metric**	**Themes of Wellbeing**
1	(Sergio Altomote, 2009)	Experimental (HDR)	 found	Daylight levels/ intensity (illuminance levels) lux/ Glare (Visual comfort)	Not found
2	(Ihab Elzeyadi, 2011)	Questioner and survey methods	 not found	Glare Index	Satisfaction with access to the outside view content
3	(Hanan Sabry , 2015)	Computational methods (Energy plus, Radiance)	 found	Daylight levels/ intensity (illuminance levels) lux/	Satisfaction with daylight quality Daylit ratio)
4	(Maria L. Amundadottir , 2017)	Computational simulation and Experimental validation (Energy plus, Radiance, HDR)	 Not found	Daylight exposure Daylight distribution patterns (uniformity)	Improve Sleep comfort/ visual interests impressions in space
5	(Ignacio Acosta , 2019)	Questioner and survey methods	 found	Daylight levels/ intensity (illuminance levels) lux Daylight distribution patterns (uniformity)	circadian rhythm

6	(Anja Jamrozik , 2019)	Questioner and Experimental validation	 found	Daylight levels/ intensity (illuminance levels) lux	satisfaction with view access
7	(Mohamed Boubekri, 2020)	Questioner and survey methods	 found	Daylight levels/ intensity (illuminance levels) lux	View clarity affect Sleep quality and productivity
8	(Marco Pesenti et,al., 2015)	Computational methods (Simulation)	 found	Daylight levels/ intensity (illuminance levels) lux (Visual Comfort)	Not found
9	(Wajiha Tariq Sheikh , 2019)	Computational methods (Simulation)	 found	Daylight levels/ intensity (illuminance levels) lux (Visual Comfort)	Not found
10	(P. Jayathissa et al., 2018)	Computational methods (Simulation)	 found	Daylight levels/ intensity (illuminance levels) lux (Reduce solar heat gain)	Not found
11	(Ayman Hassaan et al 2016)	Computational methods (Simulation)	 found	Glare Index (Visual Comfort)	Not found
12	(Amir Tabadkani et al., 2018)	Computational methods (Simulation)	 found	Daylight distribution patterns (uniformity) (Visual Comfort)	Not found

5- The analysis of the literature review

To identify the gaps in the related studies concerning daylight and shading systems, the analysis of the literature review was organized by three sub-headings (Methodological approaches, Shading potential, and Daylight metric). The following sections discuss these subheadings.

5-1 Methodological approaches

Various methodological approaches were used across the sample to quantify the daylighting non-visual effects. The most common methodological approach was based on quantifying one of daylighting visual effects firstly by using Questioner and survey methods. Then these measurements indicate the health and wellbeing potential (Ihab, M. K, Elzeyadi, 2011; Ignacio, Acosta, 2019; Anja, Jamrozika et al., 2019; Mohamed, Boubekri et al., 2020).

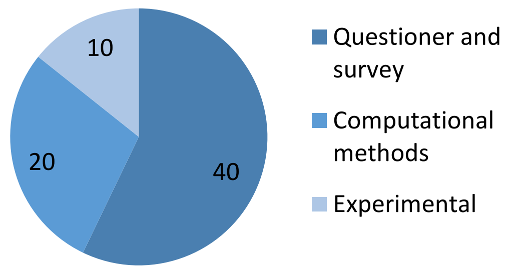


Figure 3: Methodological approaches cross the samples (Author's own).

Although Computational methods were used less method used to assess the theme of wellbeing associated with daylighting conditions (Ahmed, Sherif, 2015; Maria, L. Amundadottir, 2017), the sample shows that the most useful for computational methods was to improve daylighting conditions without referring to the health and wellbeing potential to this improvement (Marco, Pesentia et al., 2015; Wajiha, Tariq Sheikh et al., 2019; P, Jayathissaa et al., 2018; Ayman, Hassaan et al., 2016; Amir, Tabadkani et al., 2018).

5-2 Shading potential

Across the selected papers, the daylighting quality was integrated using a shading system in many cases. This integration has many objectives based on the shading function such as energy efficiency functions (Wajiha, Tariq et al., 2019; P, Jayathissaa et al., 2018) and Visual comfort (Marco, Pesentia et al., 2015; Amir, Tabadkani et al., 2018; Ayman, Hassaan et al., 2016). For example, (Wajiha Tariq; P. Jayathissa et al., 2018) investigated the design of an adaptive biomimetic façade system based on energy efficiency functions. The building facade was divided into four shading panels that can be deformed by folding forces to horizontal and vertical axes. The author designed these shading panels to reduce energy consumption inside a workspace without blocking visibility to the outside view environment (Fig.4).

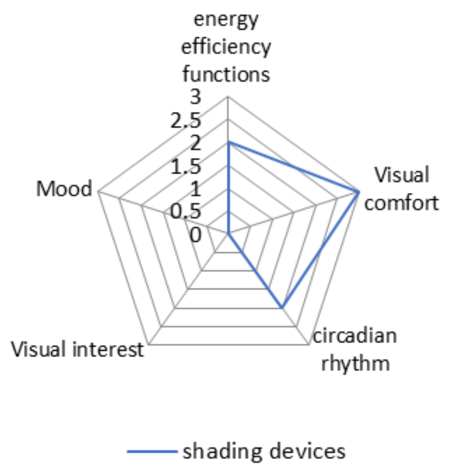


Figure 4: Themes of wellbeing trends (Author's own).

Visual comfort is usually defined through criteria based on the light level in a room, the balance of contrasts, the colour 'temperature', and the absence or presence of glare. Through this function, Marco Pesenti (2015) conduct a study to optimize a shading system's functions to improve occupant visual comfort in office space adapt to daylight Performance and Reduce Glare issues. Also, Ayman Hassaan (2016) and Amir Tabadkani (2018) investigate the possibility of improving daylight performance and reducing glare by using a kinetic shading system.

The selected sampled present two studies presenting the shading system's role to improve the well-being potential. Anja Jamrozik (2019) conducted an experiment using two shading devices- Dynamic Tint and Motorized mesh shades- for the window in the working space. These devices aim to present the impact of views on the outside environment on occupant satisfaction. Another experiment was implemented by Mohamed Boubekri (2020) using Electrochromic glass, which acts as a shading device to assess the impact of daylighting colour temperature on occupant productivity by improving his circadian rhythm.

5-3 Daylight metric

Daylighting visual metrics indices that Daylight levels/ intensity were the most metrics used most to assess themes of wellbeing (Ahmed, Sherif et al., 2015; Ignacio, Acosta., 2019; Anja, Jamrozika et al ., 2019; Mohamed, Boubekri et al ., 2020). Although the WELL standard recommended daylight exposure and states that the exposure for one hour or more in the early morning will be enough to stimulate employees' circadian system but the samples show that only one study conducted by Maria, L (et al., 2007) used Daylight exposure to assess the wellbeing and health potential. However Glare Index is considered one of the measurable metrics to quantify the visual discomfort potential, but only one study was conducted to assess satisfaction with daylight quality inside the working environment by measuring the glare index (Ihab, M. K, Elzeyadi., 2011).

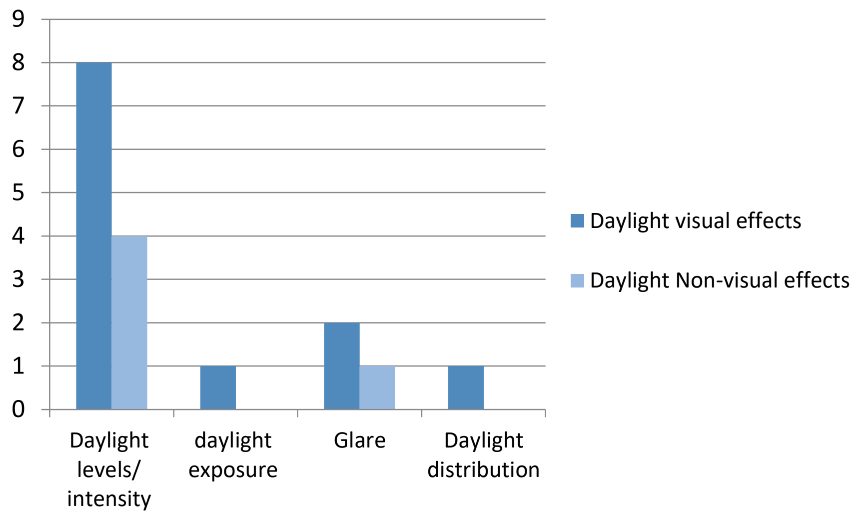


Figure 5: Daylighting metrics used to assess wellbeing (Author's own).

6- Discussion and Conclusions

6-1 Gaps in holistic perspective

The WELLv2 building standard recommended that the Occupant's ability to interact with the outside view through windows has been linked similarly to psychological advantages such as daylight. This connection can improve occupant comfort and Wellbeing because the availability to interact with the beneficial direct sunlight and view to the outside environment will reduce stress and improve worker performance (Maria, L. Amundadottir et al., 2017).

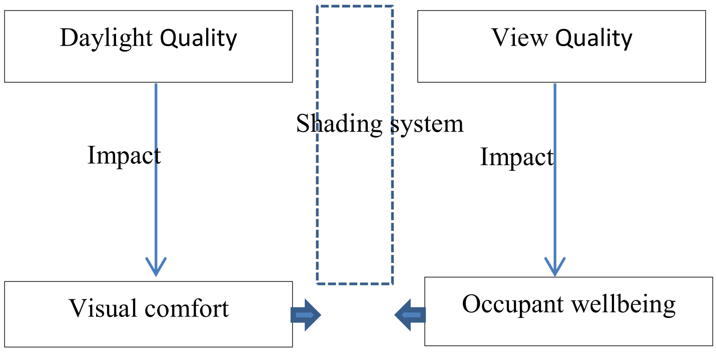


Figure 6: The Holistic approach (Author's own).

Therefore, a holistic approach is needed better to understand daylighting non-visual effects inside the working environment. This environment consists of three mandatory factors, Daylight conditions inside, outside view quality, and the layer found between them, which is the shading systems (Fig. 6). Daylighting non-visual effects are considered "Wellbeing subjective," such as the Circadian system, Alertness, and Mood. Also, daylighting visual effects are considered "Visual Comfort objectives" such as glare and Illuminance tasks needed. The effects of daylighting are both visual and non-visual; the link between these opposing paths has remained unclear, especially when using a shading system, which may prevent the outside view capability to achieve the desired luminance and avoid glare issues. Daylight visual effects and Wellbeing has been the subject of several studies to discuss their impact on occupants' perception (Ahmed, Sherif et al., 2015; Ihab, M. K, Elzeyadi., 2011; Anja, Jamrozika et al., 2019; Mohamed, Boubekri, 2020). Literature review shows that most researchers who want to evaluate the impact of Daylighting quality on occupant perception aim to quantify the Visual comfort impressions such as Glare. In addition, little attention was given to Satisfaction with outside view quality.

6-2 Gaps in methods

Satisfaction with outside view quality is considered a subjective aspect that may differ from one person to another one. Most researchers used printed-out pictures to ask the participant about their feelings. However, this method did not take into consideration the visible outside view inside the space. To our knowledge, there is no study found to assess outside view quality and its impact on occupant Wellbeing based on a computational calculation of the outside view elements visible from a viewpoint in a space that achieves the optimum daylight condition while installing shading systems. In addition, the literature shows quite an interest in studying shading devices to improve occupant wellbeing. However, most papers focus on shading devices and daylight improvement simultaneously. However, only two papers discussed how shading devices could affect the Occupant's wellbeing. This effect is conducted by improving visual interest or satisfaction with ambiance, or the amount of outside view. Very little attention was given to outside view quality.

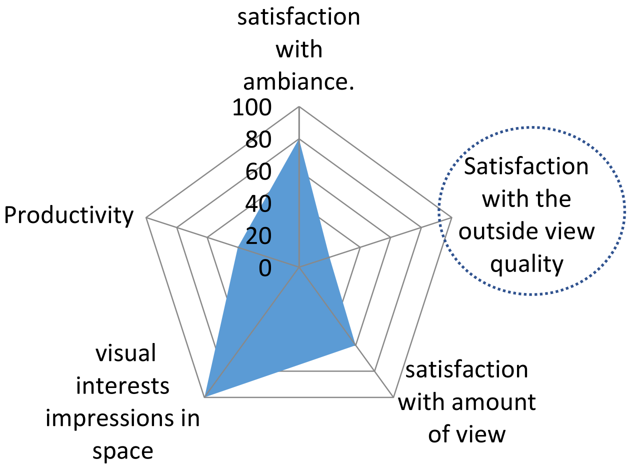


Figure 7: Gaps in Themes of wellbeing cross the samples (Author's own).

In conclusion, related studies to occupant wellbeing and daylight in the workspace show a strong relationship between the daylighting illuminance received and view quality to the outside environment. Daylight quality for visual efficiency is determined by how it is delivered and how it is integrated with the other conflicting issues such as view to the outside. Therefore, shading systems should work to not obscure the view clarity value. In addition, most researchers evaluate the impact of Daylighting on View Quality and Daylighting on Wellbeing separately; moreover, the method of evaluation of the outside view quality is often based on questionnaire results. In some cases, these questionnaires were done by asking participants to rank some pictures from different outside views. In other cases, an indicator is given to each natural element and then each outside view composition takes an overall indicator that shows the amount of sky, green, water, etc. As observed by the surveyors or researcher. To our knowledge, there is no study found to assess outside view quality and its impact on Occupant Wellbeing based on a computational method to measure the visible outside view content from a viewpoint in a space that achieves the optimum daylight condition by using shading systems.

Daylight, Comfort and Wellbeing have been the subject of several studies to discuss their impact on occupants' perceptions. In addition, the literature shows a quiet interest in studying shading devices in terms of improving occupant wellbeing. Most studies focus on shading devices and daylight improvement simultaneously but there are little attention was given to discussing the effect of shading devices on occupant wellbeing. This effect is conducted by improving visual interest or satisfaction with ambiance or the amount of outside view and very little attention is given to outside view quality. Therefore, there is a need to define a new holistic system to investigate the possibilities of using shading systems to improve daylight quality and view quality inside the working environment.

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