ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 10, pp.23205-23212, October, 2018

REVIEW ARTICLE OPEN ACCESS

REVIEW OF GLASS AS PARTITIONING MATERIAL FOR SUSTAINABLE INTERIOR SOLUTIONS IN NIGERIA

***Onanuga O. A., Duke-Henshaw O. F. and Folorunso C. O.**

Department of Architecture, School of Environmental Technology, Federal University of Technology, Nigeria

ARTICLE INFO

Article History:
Received 30th July, 2018
Received in revised form
19th August, 2018
Accepted 27th September, 2018
Published online 29th October, 2018

Key Words:
Building material, Glass, Interior partitions, Office buildings, Workspaces.

ABSTRACT

In recent years, the advent of Post Modernism geared towards meeting human needs embraced the use of sophisticated building materials as a means of improving the flexibility of building interior spaces for optimum use. The need to maximize space for various purposes, a secure light transmission that enhances both light and vision, aesthetical transparency, with excellent acoustic control around a working area is invariably needed mostly in office buildings. Glass as a choice for this purpose is one of the discovered technological innovations for interior partitioning that is of light-weight and could be self-supported (or a glass panel with frames as a support for the glass). This paper takes a keen look at the inherent properties of glass that makes it a robust and sustainable solution for the interior design. The result will reveal and educate on the importance of glass panels' internal partitioning technology in improving the workspaces and how well it relates to the building occupants and services control.

Citation: Onanuga O. A., Duke-Henshaw O. F. and Folorunso C. O. 2018. "Review of glass as partitioning material for sustainable interior solutions in Nigeria", *International Journal of Development Research*, 8, (10), 23205-23212.

INTRODUCTION

Over the years, workplaces have begun to fall into a certain rut, being impacted by issues such as everything from dark, poorly lit spaces and cramped cubicles to poor indoor air quality caused by choice of building materials for the interior partitions. The architecture of building interiors, mostly in office buildings, supposed to be geared towards a maximum use of spaces for various purposes, affording both light and vision, aesthetics with the excellent achievement of acoustic control around a working area. Many technological innovations like aluminium, stud, plywood, particle boards partitioning to mention a few, have been adopted in office partition to achieve this purpose. The use of glass panel can be seen to be a better choice for achieving an improved architectural interior due to its numerous advantages over other building materials for an interior arrangement which could be from secure light transmission and functions to transparency that enhances both light and vision into as far as spaces within a space. It can, therefore, be as an alternative solution to energy insufficiency challenge that engulfs mostly in the developing nations.

****Corresponding author:*** **Onanuga Omotayo Adebayo**
Department of Architecture, School of Environmental Technology, Federal University of Technology, Nigeria

The Palm House conservatories in Kew (1848) designed by Turner and Burton; the Crystal Palace exhibition halls in London (1851) designed by Paxton (Fig. 2) and the Great Railway sheds in London designed by Pancras and Paddington are the early examples of buildings that exposed the discovery of glass as a building material (Dawson, 1999). Shopping streets were covered by glazed roof structures to protect customers from the weather, with different examples like the Galleria Vittorio Emanuele in Milan (1861) designed by Mengoni (Fig. 3); Waterloo terminal in London (1993) designed by Nicholas Grimshaw and glass Orangery in Prague designed by Eva Jiricna (1998), with frameless glass panel suspended from a steel structure (Dawson, 1999; Danijel, 2008). The fascination that glass inspires in designers is explained by the innovative installation techniques as shown in figure 1. That is, structural glazing or bolted glass assemblies and frameless glass partitions which utilize a head, wall and floor aluminium channel with 10mm or 12mm thick clear toughened safety glass, which is then, joined together with plastic H sections or silicone joints; thisis really a breakthrough in glass invention (McGraw Hill, 1997). The glass panel is a compound building component, which comprises of glass and frame materials that could be aluminium, plastic or wood or a self-supported frameless glass joined together with a head, wall and floor aluminium channel.

It is an ancient building material, which enabled penetration of light into buildings. Once, it was used exclusively for window panes, whereas nowadays glass panels are seen littered the buildings in the streets of many cities globally. Aside from the aesthetical benefit of glass materials on windows and façade of buildings, glass connects the space by transmitting sufficient light into the interior; thereby, improves the quality of space and transmits sufficient light. By varying their quantities and using certain special additives, the properties and characteristics of glass are modulated to obtain a large variety (British standard, 1995; British standard, 2000). The unique and essential quality of architectural glass is in its ability to transmit daylight, heat insulation, noise control, aesthetic value, better communication among others. There are hundreds of glass compositions as well as different coatings, colours thicknesses, and laminates, all of which affect the way light penetrates the material. The types of glass used; like Annealed glass (which can be clear glass, tinted glass, pattern or rolled glass, wired glass, or ceramic printed glass), laminated glass, tempered glass, reflective glass, or insulating glass in building interior is dependent on the level of illumination needed. In this context, it is therefore required to reappraise glass material in reflecting the merits in its use for office interior partitions and make explicit the understanding needed for the adoption of the material as a medium of improving the quality of interior spaces of office buildings in Nigeria. It will also help in understanding the treatment of problems associated with good workspace and comfort of the end users as the construction industry is on the fast track regarding innovations and physical development combined with diversified human activities.

Glass panels: A revolutionary element of the 20th century

Scheerbart's (1914) in the book 'Glasarchtektur', vividly expressed the dream of a world revived by glass architecture. The innovation served as an inspiration to the then emerging modern movement in architecture and revealed the potential of glass technology. Today, the vision of architectural design 'made entirely of glass' is achievable. Archaeologists have found evidence of human-made glass which dated back to 3500 BC in Egypt and Eastern Mesopotamia (Glass Online, 2007; Stern, 1999). The plain raw materials of glass were being used mainly to produce glazes on pots and vases. The oldest fragments of glass vases (evidence of the origins of the hollow glass industry), however, dated back to the 16th century BC and were found in Mesopotamia. Hollow glass production was also evolving around this time in Egypt, and there is evidence of other ancient glassmaking activities emerging independently in Mycenae (Greece), China and North Tyrol (Braghin, 2002). By 1500 BC, the first hollow glass container was made by covering a sand core with a layer of molten glass. There was little sign of further evolution until the 9th century BC when glassmaking revitalised in Mesopotamia. Over the following 500 years, glass making centred on Alexandria, from where it is thought to have spread to Italy. A breakthrough in glassmaking was the discovery of glassblowing sometime between 27 BC and AD 14, attributed to Syrian craftsmen from the Sidon-Babylon area (Glass Online, 2007). However, beginning in the seventh century, Muslims conquered lands extending from central Europe to Spain. Glassmaking flourished through the region. Islamic glassmakers revived Roman techniques and developed new forms and types of ornament (Ahmad, 2009). Glass blowing became the collective way to make glass containers from the First Century BC. However, the glass made during this time was highly coloured due to the impurities of the raw material. At about 50 B.C., glassmakers on the Syro-Palestinian coast, then part of the Roman Empire, discovered that they could more easily form objects by inflating a gob of glass on the end of a hollow tube. This rapid process made glass affordable and widely available for ordinary household use. However, the Romans also formed some of the most extravagant luxury glass ever made (Lilyquist, 1993). It was the Romans who began to use glass for architectural purposes, with the discovery of clear glass (through the introduction of manganese oxide) in Alexandria around AD 100 (Fleming, 1999; Stern, 1999; Toner, 2009). Cast glass windows, albeit with poor optical qualities, thus began to show in the most important buildings in Rome and the most luxurious villas of Herculaneum and Pompeii (Glass Online, 2007).Towards the year 1000, a significant change in European glassmaking techniques took place. Given the difficulties in importing raw materials, soda glass was replaced gradually by glass made using the potash obtained from the burning of trees. At this point, glass made north of the Alps began to differ from a glass made in the Mediterranean area (Hamilton, 2000). The developments by German glass artisans of a technique in the 11th century and then further advanced by Venetian craftsmen in the 13th century brought about the advent of the production of glass sheets. With this technique, a glass ball was blown and then opened outwards on the opposite side to the pipe. Spinning the semi-molten ball then caused it to flatten and increase in size, but only up to a limited diameter (McCray, 2007; Michael, 2008). The panes thus created would then be joined with lead strips and pieced together to create windows. Glazing remained, however, a great extravaganceup to the late Middle Ages, and was mainly used in royal palaces and churches (Evison, 2000; Heyworth, 1992 and Glass Online, 2007).

Stained glass is a general term casing all forms of glass used decoratively, primarily for Windows, but also for a myriad of practical uses prevalent today. Stained glass has a coloured material applied to its surface, and it is usually fired in a kiln to ensure a more robust finish. It can be put in place to decorate, instruct, inspire, allow in light, block out light, commemorate, hide an unwanted exterior view, memorialise or any of literally hundreds of goals (Stained Glass Association of America, 2012). Stained glass will, as no other medium can, charge a room with energy and light (The Glass Portal, 2012). The skill of the artisan engraving the glass will determine the quality and detail of the resulting piece (British Glass Manufacturers' Confederation, 2011). Stained glass windows stretched to its peak as the Middle Ages drew to a close, with as welling number of public buildings, inns and the homes of the wealthy fitted with clear or coloured glass decorated with historical scenes and coats of arms (Glass Online, 2007). Mass production of sheet glass, the development of steel frames, cable structures, fixing devices and systems as well as of elastic sealant changed things and resulted in someinnovative answers and policies. During the twentieth century, the curtain wall appeared with new types of glazing. However, on the façades of the skyscrapers, linear glass fixing components were still present. In recent time glass frames have developed into high-tech components: polyvalent or intelligent envelopes. These have a role to play in the control of thermal quality such as heating, ventilating, cooling, air conditioning and lighting (British standard, 2000; Celeste, 2010 and Sherwin 2012). Apart from the traditional non-load bearing application in engineering, glassis used progressively for the construction of

load-bearing elements. The progressively stricter regulations dealing with the energy efficiency of the buildings give rise to the application of unique characteristics glass of high-performance, but also to the more intensive research in this field. The adequate choice of the glass type can to a great extent improve the energy efficiency of the building. Glass, beyond its architectural aspect and structural capabilities, have been developed with new properties to meet the modern demands of comfort as well as safety and security (British Standard, 2000). It is a type of construction material that is traditionally multifunctional and continuously evolving, retractable and removable (aids conversion of space), which makes it the choice for an interior partitioning. The advents of new requirements for building, such as the accommodation of information technology, and the development of new glass technology to these requirements (e.g. the deposition of electro-conducting coating) are generating new glass performance (McGraw, 1997). Insulation is of late fitted to the cavity of the stud to aid soundproofing. Sound reduction values for the glass partitioning in the 4mm to 10mm thick is from 52db to 43db (Smith, 1996). The glass earn the robust and sustainable solution for the interior design profession from its inherent properties. Glass surfaces meet high performance criteria for quality and durability and have the advantages of ease of maintenance, heat resistance, durability, scratch resistance, Stain Resistance, Colorfastness, Standard Fabrication, and Food safety (Celeste, 2010; British Glass Manufacturers' Confederation, 2011; Polycor Vetrazzo Inc., 2011; The Glass Portal, 2012; http://www.glazette.com/Glass-Knowledge-Bank, 2012). According to Hes (2005) integrating green innovation like glass into the built environment is a terrible problem, which makes identifying barriers hindering this practice essential (Aye, 2003; Mate, 2006; US green building council, 2003). Studies have shown that people have a keen interest in sustainable interior design. However, the frequency of application is stumpy (Aye, 2003; Kang & Guerin, 2008; Kang & Guerin, 2009; Mate, 2006).Therefore, there is the need for more research to further enlighten the interior professionals and the people on the merit of maximising the use of glass material for internal enhancement and a better productive workstation.

Glass usage in the modern world

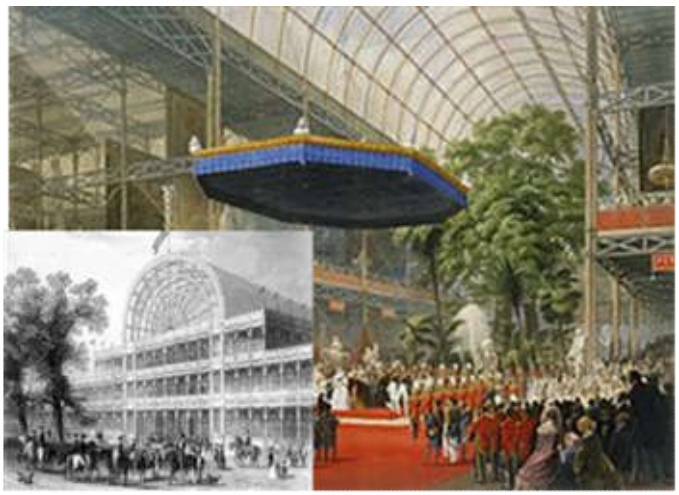
Bruno Taut, in a pamphlet produced for the opening of his Glashaus glass pavilion for the Werbund exhibitions in Cologne in 1914, described the building as having no other purpose than to be beautiful. Glass was no longer only a functional light admitting material, it now embodied an aesthetic and symbolic role. In the pavilion, glass was everywhere. Wall, ceiling, floors and staircase were all finished with translucent or transparent glass. The Taut aim was the enclosure of space using glass. He also introduced coloured, opaque and transparent glass, to create the various effect using their optical qualities. This idea of glass as a beautiful material in its own right found a continuing embracement in the architecture of Gropius, Mies Van der Rohe and Le-Corbusier. ING House (Figure 7) was commissioned by the ING Bank to serve as the Bank's Headquarters at Southern Amsterdam. The building, resembling a giant beetle in shining glass and anodised aluminium, rests on ten-metre-high pillars. The ample use of glass gives everyone working in the building great views. The project was awarded the "Glass" Award among the many prices also assigned to the project. Also, Javier Pérez Uribarri designed the principal office of Idom Group Headquarters in the Port of Bilbao, Spain in 2010and achieved the aim of large open workspace, with extensive intra and inter-departmental visual communication, without barriers between the various departments and personnel of Idom Group through the use of interior glass partition. Kate Macpherson UNIKGLASS OFFICE FRONTS embraces a modern team workplace paradigm. The design of the 2,500 square foot (Fig. 5) work environment in 2012 was fostered by the vision and leadership of the Partners to provide a collaborative atmosphere that is unordinary, logical, and essentialist. He used abundant glass which allowed visibility, connectivity, and natural daylight to permeate the spaces. The San Diego National Wildlife Refuge located within Sweetwater Marsh was the design of Johnny Birkinbine in 2010. He explained that the overall design rationale for the interior of the project was to keep everything light and open, to minimize the need for conventional lighting, resulting in significant energy savings. He opined that the ability of the glass walls to extend natural daylight deep into the interior of the space helped increase energy efficiency and contributed to the daylight and views credit. Toledo Museum's Glass Pavilion in Toledo (the US, 2000-2006) designed by SAANA architects combines the most advanced structural, material, environmental and aesthetic knowledge creating an elegant building that could not have been realized a generation earlier (Fig. 6). It is a single storey pavilion where the interior curved glass walls form the galleries. Between the galleries, there are cavities used for ventilation and heating. The structure combines steel framing in the roof and concrete in the floor with glass for other elements (Danijel, 2008).

Source: Google Image 2013

Figure 1. Picture showing glass fitted into cavity of aluminium stud

In 2006, the design by Mauro Valenti interacted and coordinated with his previous projects, involving the executive offices and other parts of the interior that are divided using the glass partition wall system for the central Headquarters of the Catalonia Police Force (Mossos D'esquadra) in Barcelona. The design concept based was on achieving a proper feel that creates multiple but separate individual workstations. The design was aimed at and achieved through interior glass partitions in the Rome Chamber of Commerce with a system of dividing walls from its partition range was used to provide multiple small spaces in sequence. Another example of glass pavilion is Leonardo Glass Cube in Bad Driburg (Germany) designed by the architects 3delux and inaugurated in 2007

(Fig. 8). The integrative design concept combines architecture, interior design and landscape design into a complex aesthetic entity. Inside the pavilion, the curved white wall creates an open space. Between the curved wall and the glass façade, a hall provides space for meetings and events. The glass facade allows interplaying with the surrounding landscape (Danijel, 2008). Treatment of interior architecture was also felt in the works of Piero Lissoni (The La Rinascente centre, 2006), and Eugenio Gerli (renovation and restoration of the Castiglioni Palace in 1903); Commerce and Tourism Union in Milan in Corso Venezia, 1947-49; and the Cardiology Clinic in Laveno-Montebello, 1950) among others. Several other examples of recently designed and constructed glass pavilions exist around the world. Their similarities lay in the intention to make the pavilion as transparent as possible, to build steel structural frame strong enough to carry the imposed load, but at the same time are subtle enough not to disturb the clearness and transparency of the structure. Further improvement in the brightness of glass pavilions is seen in the fully-transparent glass pavilions, which employed glass envelope as a primary structural element capable of carrying and supporting the entire structure.



Source: www.archdaily.com

Figure 2. Crystal Palace exhibition hall, London (UK)

Source: www.archdaily.com

Figure 3. Galleria Vittorio Emanuele, Milan

Partitioning technology in the developing countries: The Nigeria context: Hard partitioning with the use of block had been a method long adopted in the design of interior partitioning in most of the office buildings in Nigeria (Fig 10). It has been used for an ample number of the building interior partition in the construction industries. This rigid method of partitioning in most of the commercial complexes in Nigeria has in return make structures hardly convertible in use and brings about lots of expenses during building transmutation. Osmani *et al.* (2007) in their research on waste minimization discovered that clients show no concern on the reduction of waste coupled with their view that waste is inevitable. This poorly defined individual responsibilities and this lack of understanding created a barrier to minimizing waste in the construction process. The moderation of the interior arrangement partition made of this rigid material added to the environmental pollution via dust. Also, it has increases waste generation (as the industry is lagging behind in material re-use system), inflates the cost of services (as the cost of demolishing the rigid materials is almost the same as the cost incurred in the erection of those materials) among many other demerits.

Even the waste generated is always used in filing derelict service roads since in some cases, disposal of those waste proves difficult (US Environmental Protection Agency, 2012). The hard partitions decrease the flow of natural lighting across the office spaces and separate occupants of the building. The dim lighting has a negative impact on creativity, satisfaction, happiness, and even the health of the users. Psychologically, people feel as though they were trapped behind the walls and cut off from other people in the office with such partitions. So also, the physical barriers cause visual barriers that decrease communication and makes it harder to foster an environment of creativity. Most developing countries are known for their shortcoming in infrastructure. It is now stale news that power supply is irregular in Nigeria. Treating the interior with hard partition results in a poor working environment, in this case, the cost of providing sufficient lighting into the interior will increase. Poor working environment derails workers morale and reduces the productivity of the entire team. Closed-off offices are of most benefit to the lazy workers as they feel shut behind walls and doors all day, thereby do as they please since they are without monitoring. More time is wasted on non-work activities by the employed staffs being aided by the opaque partition material used, thereby, production suffers retardation. Although some office designers have adopted the use of particle board with half of its height been glass material (Fig. 9) to solve the challenge of illumination while some adopted open plan with partitions done with furniture arrangement for the same purpose (Fig.11). It has been seen to have solved the challenge of illumination a little, but fails in space definition, noise control and concentration.

Identified constraint

Sherwin (2012) stated that if environmentalism's success were in spotlighting sustainability problems to the world, the success of design would be in helping deliver solutions. Some multiple barriers were identified from past literature as the authors dig deeper into understanding the reason behind the low use of glass material for the interior partition in incorporating sustainable interior design into practice. The most influential among the barriers is the perceived cost of the glass material (Aye, 2003; Mate, 2006). Arbuthnot (2009) explained there is less of a chance of making a sustainable choice when an action, in this case, a sustainable interior design practice, is perceived as beyond one's control.

Source: Google Image 2013

Figure 4. Picture showing transmission of artificially light only through glass in an interior office setting

Source: Macpherson Facebook page 2012.

Figure 5. Picture showing the interior of UNIK GLASS OFFICE by Macpherson

Figure 6. Toledo Glass pavilion, Toledo (USA)

Some other identified constraint through several types of research are the time to source materials, knowledge of the technicality, client resistance, material demands, client knowledge and feedbacks, a limited supply of the material selection and authenticity of suppliers (Aye, 2003; Hes, 2005; Davis, 2001; Mate, 2006). Likewise, factors such as the understanding of the impact of materials, accurate and accessible information and appropriate tools were identified (Kang and Guerin, 2009).

Figure 7. ING House, Amsterdam, the Netherlands

Figure 8. Leonardo Glass Cube in Bad Driburg (Germany)

Source: Google Image 2013

Figure 9. Picture showing creation of separate office within office setting

Time constraint, consultation process, last-minute design changes by the client and detailed errors in the application of this sustainable design practices are rated among the significant retarding factors that discourage the usage as it contributes significantly to design waste (Osmani *et al*., 2007). Lack of client interest changes to meet the client's requirements and preferences do not play a quiet role as well. Given that these factors show more relationship with the project client, many studies have suggested the need to educate clients and the public being an essential step in the achievement of a sustainable indoor space through viable choice (Fujii 2006; Arbuthnott, 2009; Osmani *et al.,* 2007). The occupants of a building have a significant impact on the selection of materials, finishes and products, furnishings and appliances, and maintaining healthy indoor environments (Loftness, 2007). When considering consumer education, Arbuthnott (2009) discovered that public teaching was more effective when focused on specific pro-environmental behaviours rather than more significant environmental issues.

Benefit of glass interior partition

Having glass partition walls in the offices has several merits. Clear glass partitions is an innovative way of providing privacy and sectional working areas in an open space, while giving the office a modern, spacious look (Fig. 4). It is an innovative, modern and stylish alternative to traditional partitions. The most significant financial reward of having glass partition is to reduce dependency on artificial lights in office throughout the day. It means the use of less electricity in offices and thus reducing energy consumption, throughout the year. Also, it will not just increase energy efficiency but will have a positive effect on the environment. Glass panel isa cost-effective way of dividing rooms requiring minimal or no structural modifications, thus keeping the costs low (Fig. 13). - Another benefit of glass partitioning material in offices is in its enhancement in efficiency and productivity among the workforce. It helps the employee to carry out work more quickly and thus can improve work output to a greater extent, which ultimately reduces time spent, money and resource (Werner Vogel 1994; Hennesy, 1996; Abdou, 1997). It also enables the ability of easy management of different business works. Glass partitions can also be useful in creating sectors of privacy within office spaces (Fig. 12). Glass partitions not only separate space effortlessly, but also allow the wide-ranging interest and texture yet maintain a functional but straightforward manner. Furthermore, glass partitioning gives an excellent opportunity for flexibility being easily remount able and can be moved from one place to another in case of space rearrangement or space creation in a particular area of the office. The most significant advantage of glass partition lies in its flexibility (Werner, 1994), which gives room for the rearrangement of the interior layout as deem fit depending upon the needs and circumstances with or without the attachment of other partition options (Fig. 14). Insulations are fitted to the cavity of the stud of the glass panel to aid sound proofing (Fig. 1). Light has a direct effect on mood, emotion and outlook. The use of glass as interior partitions assists the flow of light in the office, allowing more than those sited next to the windows to benefit thereby improving the interior visuals. Aesthetic perception plays one of the most critical roles in the use of glass partitioning. Most glass partitions come with various designs ranging from clear vision to distorted ones while colour is not left out.

Figure 10. Pictorial view of a typical office partitioned with block material

Figure 11. Pictorial view of an open office design for airtel

Source: Google Image 2013

Figure 12. Picture showing a sector of privacy within an office space

They can assist in creating an airy and light office environment. Clear glass is used for forming an effect on open space (Fig. 14) and where privacy is needed, the use of film, frosting, or coloured glass designs becomes valuable (Fig. 12).

Source: Google Image 2013

Figure 13. Picture showing transmission of light aided by glass in an interior office set

Source: Google Image 2014

Figure 14. Pictures showing a clear view within partitions in an interior office setting

Source: Google Image 2014

Figure 15. Pictures showing division of office spaces into multiple partitions

With this, glass partition gives a professional look to the office which will ultimately influence and impress visitors. Glass wall systems allow you to create a beautiful environment in the office without losing the functionality of the space. Many people agree that glass doors and walls improve the functionality of their space, especially when installing in office units and other small spaces. Glass walls are not limited to small spaces though, because they can be a great addition to a large office as well. No matter the size of the office, glass partition walls allow transparency, comfort, efficiency, and effortless transitions within the office. The possibilities are endless, and thus creates the opportunity to choose the perfect design for interior spaces. These wall systems aren't limited to office space, because they can also be used to add unique design elements to the home. Glass partitions help to sub-divide a shared open space into multiple partitioned areas, creating a complete room inside a bigger space, while adding a decorative division (Fig. 15). It can be a distinct advantage when personnel are working together on a project. Clear view within partition offices makes communication more comfortable and gives encouragement and strength among team members working on a common goal, this in turn also serves as a check on the diligence of team members.

Conclusion

Glass panel which is made up of different components has developed into a material that meets every need in the interior of a building. Maximum use of natural resources benefit as to properly illuminating the interior spaces coupled with the excellent output of working scheme in offices can significantly be achieved by eliminating the boundaries within workspaces. Use of glass as a partition of interior spaces improves the workstation, enhances considerable cost savings while providing an eco-friendly solution with an array of bright and definable benefits. The barriers to the use of glass partitioning identified are the lack of enough information on the use of the material for sustainable interior design among other constraints. Interior design education should be factored and emphasis on sustainability with a bias towards the use of glass materials in interior spaces mostly in the developing countries. The method of technology to minimize waste production; modification of generated waste to suit application; and waste re-use in interior spaces is necessary information that should be made available for public consumption. Also, there is a need to fortify the dissemination of knowledge, information and skills to the public regarding the advantages of using glass partitioning material in interior spaces through in-depth researches. Space owners' resistance to the use of glass panel for interior partitions and the opposition to change by stakeholders in the interior design industry instigate the worse use of the partition material. It has, in turn, killed the moral to explore, use and recommend the materials in interior space designs. Given this, educating stakeholders in the construction and interior design industry on the benefits of using glass for interior space partitions, encouraging application and its use for sustainable design practices will go a long way to resolve the generic interior challenges. Further study can also look into the extent to which the barriers identified affects the use of glass material for interior partitions in developing countries.

REFERENCES

Abdou, O. A. 1997. "Effects of luminous environment on worker productivity in building spaces." *Journal of Architectural Engineering.* Vol. 3; pp. 124-132.

Ahmad Y. AL-Hassan 2009. "An eighth-century Arabic treatise on the colouring of glass: Kitāb al-durra AL-Maknūna (the book of the hidden pearl) of Jābir ibn

Ḥayyān (c. 721– c.815)."*Arabic Sciences and Philosophy*, 19, pp 121-156.

Arbuthnott, K.D. 2009. "Education for sustainable development beyond attitude change." *International Journal of Sustainability in Higher Education.*

Aye, E. 2003. Taking the Pulse: Sustainability and the Interior Design Practice, Green Building Services.

Braghin, C. 2002. "Polychrome and a monochrome glass of the Warring States and Han periods." In Braghin, C. (ed) Chinese Glass. Archaeological studies on the uses and social contest of glassartefacts from the Warring States to the Northern Song Period (fifth century B.C. to twelfthcentury A.D.). ISBN 8822251628.

British Glass Manufacturers' Confederation, 2011. http://www.britglass.org.uk.

British Standard, 1995. Glass for glazing. Classification, BS 952-1: 1995. Pg. 65.

British Standard, 2000. Glass in building. Security glazing. Testing and classification of resistance against bullet attack, BS EN 1063. Pg 59.

Celeste Allen Novak, A.I.A, 2010. LEED AP, Ann Arbor, Michigan, http://aiapgh.org/featurearticles/celeste-allen-novak-aia.

Danijel Močibob, 2008. Doctoral Thesis: Glass panel under shear loading - use of glass envelope for building stabilization. Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland.

Davis, A. 2001. Barriers to Building Green, http://www.architectureweek.com.

Dawson, S. 1999. Working details. Emap Construct.

Evison, V. I. 2000. "Glass vessels in England, 400–1100 CE" pp. 47–104 in Price, J. Glass in Britain and Ireland AD 350–1100. London: British Museum Occasional paper 127. ISBN 0861591275.

Fleming, S. J., 1999. Roman Glass: reflections on cultural change. Philadelphia, University of Pennsylvania Museum of Archaeology and Anthropology.

Glass Online: The History of Glass". Art energy Publishing S.r.l. Retrieved 2011-04-15. http://www.glassonline.com/ infoserv/history.html.

Hamilton, D. L. 2000. Glass conservation. In Conservation Research Laboratory. Texas A&M University College Station, TX.

Hennesy, T. 1996. "Open to change: Day-lighting creates wide-open feelings and a maze of options". Store equipment and design.

Hes, D. 2005. Facilitating 'green' building: turning observation into practice. PhD dissertation, RMIT University, Melbourne.

Heyworth, M. 1992. "Evidence for early medieval glass-working in north-western Europe" pp. 169–174 in S. Jennings and A. Vince (eds) Medieval Europe 1992: Volume 3 Technology and Innovation. York: Medieval Europe 1992.

Kang, M. and Guerin, D.A. 2008. The characteristics of interior designers who practice environmentally ustainable interior design. Environment and Behavior. *American Journal of Environmental Sciences.*

Kang, M. and Guerin, D.A. 2009. "The state of environmentally sustainable interior design practice." *American Journal of Environmental Sciences,* Retrieved from http://www.scipub.org/fulltext/ajes/ajes52179-186.pdf.

Lilyquist C. 1993. "Granulation and Glass: Chronological and Stylistic Investigations at Selected Sites, ca. 2500-1400 B.C.E.", *Bulletin of the American Schools of Oriental Research,* JSTOR 1357319.

Loftness, V., Hakkinen, B., Adan, O. and Nevalainen, A. 2007. "Elements that contribute to healthy building design." *Environmental Health Perspectives.*

Mate, K.J. 2006. "Champions, Conformists and Challengers: Attitudes of Interior Designers as Expressions of Sustainability through Material Selection." Paper 0066. Paper presented at the *Design Research Society International Conference.* Wonderground, Lisbon.

McCray, W. Patrick, 2007. "Prehistory and history of glassmaking technology." *American Ceramic Society,* ISBN 1-57498-041-6.

McGraw- Hill, 1997. Handbook of Glass in Construction, Journals, p.157-165, no.2, 2005, http://www.journals. cambridge.org.

Michael Cable, 2008. Bontemps on Glassmaking: the Guide du Verrier of Georges Bontemps, translated by Michael Cable (2008). Society of Glass Technology. ISBN 0900682604.

Osmani, M., Glass, J. and Price, A.D.F. 2007. Architect's perspectives on construction waste reduction by design, *Waste Management Journal.*

Paul Scheerbart, 1914. 'Glasarchtektur,' emerging modern movement in architecture.

Polycor Vetrazzo Inc., 2011. Original recycled glass surface manufacturers, www.vetrazzo.com, USA.

Price, J. 2000. Glass-working in Early Medieval England, Glass in Britain and Ireland AD 350–1100, London: British Museum Occasional paper 127.

Sherwin C. 2012. Head of sustainability at leading Seymour-Powell design and innovation consultancy Smith, B. J, 1996: Acoustics and noise control, 2nd edition. Pg. 25.

Stained Glass Association of America, 2012. Sourcebook, the Stained Glass Quarterly, Printed in the U.S.A.

Stern, E. M. 1999. "Roman Glassblowing in a Cultural Context." *American Journal of Archaeology* 103, pg. 441-484. Doi: 10.2307/506970. JSTOR 506970.

Stern, P. 2000. Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues.*

The Glass Portal, 2012. With Resources on Glass in Green and Sustainable Architecture, Interior Design and Innovations in Glass.

Toner, J. P. 2009. Popular culture in ancient Rome. ISBN 0-7456-4310-8. p. 19.

U.S. Environmental Protection Agency, 2012. "Glass, Common Wastes & Materials."

U.S. Green Building Council. 2003. An Introduction to the U.S. Green Building Council and the LEED Green Building Rating System, www.usgbc.org/Resources/ research.asp.

Werner Vogel, 1994. "Glass Chemistry"; Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2nd Revised edition (November 1994), ISBN 3-540-57572-3.

****