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Furniture Design and Flexibility in Office Spaces

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Abstract: *This research paper aims to investigate the concept of flexibility in furniture in open office systems and identify the parameters that affect the work environment.*

The study will explore how ergonomics, trends, design criteria, and materials influence the design, performance, and usability of furniture in open office systems. Additionally, the research will identify the challenges and opportunities of incorporating flexibility into furniture in open office systems. The research will be conducted through a literature review of existing studies focusing on the use of furniture in open office systems. Furthermore, interviews with furniture designers, architects, and other experts in the field will be conducted to gain insights into the current state of open office systems and the design criteria for furniture.

The results of the research will be used to develop guidelines for incorporating flexibility into furniture in open office systems. The findings of the research have the potential to help improve the usability and comfort of workspaces, while allowing for better adaptation to changing needs.

Keywords: *flexibility, ergonomics, modularity, materials, open-office, work environment.*

I. INTRODUCTION

Many people spend more than half of their life at work, in indoor physical situations that affect their thoughts, emotions, and actions, with only around 16.5 hours of waking time each day. The open-plan office, which is distinguished by movable partitions that separate individual workspaces, is the most common type of office layout. Over 70% of office workers work in open-plan environments.

Open-plan offices give businesses more flexibility when it comes to space layout and requires less space per occupant, which lowers real estate costs. It is crucial to understand how the open-plan office's elements for furniture design and layout enhance flexibility and the working environment.

This study aims to analyze flexibility in furniture in open office systems and identify parameters affecting the work environment. Furthermore, to create a set of guidelines that can be used in open office systems to enhance flexibility and improve the work environment.

The main objectives are, to study flexibility in furniture in open office systems, to identify and analyze the parameters for furniture in open offices to improve the work environment and flexibility, to analyze the impact of providing employees with flexibility in terms of furniture on their productivity & satisfaction and to determine the guidelines for selecting furniture for open office systems that can enhance flexibility and improve the work environment.

A. Methodology

The study will begin with a literature review of existing research on furniture flexibility and its effects on the work environment in open office systems. This review will provide an overview of previous studies and identify key parameters that have been studied in the past. From this review, a set of research questions will be developed to guide the study. The study will then use a qualitative research approach to examine the parameters affecting work environment in open office systems. Semi-structured interviews and focus groups will be used to collect data from a variety of stakeholders, including employees, supervisors, and other personnel involved in the implementation and maintenance of open office systems. The data will then be analysed to identify patterns and themes related to furniture flexibility and the work environment in open office systems. From the results of the analysis, a set of guidelines will be developed to improve the work environment and enhance flexibility in open office systems. These guidelines will be based on the parameters identified in the literature review, as well as the findings from the qualitative research. The guidelines will be evaluated by an expert panel of stakeholders, and revised as necessary. Finally, the study will conclude with an exploration of potential future research topics related to furniture flexibility in open office systems. This will include a discussion of the implications of the results of the study, as well as recommendations for further studies.

II. LITERATURE STUDY

Office furniture plays an important role in the comfort and productivity of employees in the workplace. Studies have shown that office furniture can have a significant impact on employee morale and performance (Ling, et al., 2017).

A study on Flexibility in Modular Furniture Systems in Open Offices (E. Farjami, 2014), recommends new furniture flexibility technologies in addition to modular office design to assist people in having pleasant places with the best furniture and organized plans that can function more efficiently than the old systems.

The findings of Flexible work arrangements in open workspaces and relations to occupational stress, need for recovery and psychological detachment from work (Stefanie Mache1, Ricarda Servaty and Volker Harth, 2018) add to our current understanding of flexible work arrangements in open offices.

They can be utilized to create new work environments that will improve employee performance and well-being. There are also recommendations for future research as well as additional practical consequences. A study on environmental satisfaction with open-plan office furniture design and layout (Jennifer A. Vetich & Kate E. Charles, 2002), shows that it is evident that inhabitants have higher environmental satisfaction when they perceive their demands as being met.

Meeting. It is possible to increase pleasure by addressing individual needs, which differ depending on the type of work, the individual, and the task at hand.

The primary three FWA methods—flexibility in workload, flexibility in the workplace, and flexibility in working hours—demonstrate the main benefits and drawbacks of each, particularly flextime, and demonstrate how organizations can determine the appropriate level of flexibility by contrasting favorable and unfavorable results (Mohamed Ayman Abdel Amal Abdelrahman Elsayed, 2015).

The study on the influence of flexible work arrangements on employee engagement (Marcel Weideman Karl B. Hofmey, 2020) found a positive relationship between FWAs and employee engagement. It also revealed that FWAs were positively associated with various employee engagement constructs found in the literature, with the most prominent finding showing positive influence of FWAs on employee well-being.

Office furniture design redefining office spaces (Pradanya Patil, 2022) defined the parameters that are helpful to meet the needs of ever-evolving workspaces to make them more efficient for the users, ergonomics, materials survey, trends.

A study on the design of flexible furniture for the new generation offices (Didem Bedük Tuncel , Hande Zeynep Kayan, 2020), describes lightness, mobility, transformability, acoustics, and technology adaption are seen as highlights of furniture design in flexible workspaces that suit the current generation's shifting demands and expectations.

A. Parameters

The key parameters have been developed from the literature review of existing research on furniture flexibility and its effects on the work environment in open office system.

- Anthropometry & Ergonomics
- Materials
- Design criteria
- Trends

1) Anthropometry & Ergonomics (Indian standards) User

Perfect positioning with the proper products:

- a) Ensure that your feet are firmly planted on the floor by adjusting the height of your seat.
- b) B. Your seat should be deep enough for the backs of your knees to stretch past the edge of the seat. The floor should be roughly parallel to the thighs.
- c) D. You shouldn't have an upward or downward wrist angle.
- d) E. Adjust the work surface's height so you can work comfortably without bending or straining. Place frequently used things (such as a phone and a stapler) at a convenient location.
- e) F. The top third of your computer screen should be at or below eye level, and you should have at least 18 degrees—typically an arm's length—between your eyes and the monitor.
- f) G. A document holder aligned with the monitor's front.

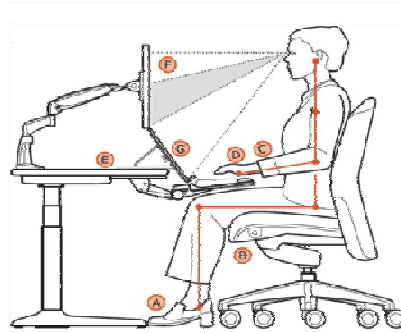


Fig 1: Ergonomic positioning

2) *Materials*

The selection of materials for open office furniture should consider durability, aesthetics, and cost. Durable materials such as steel and laminate are often preferred as they are easy to clean and maintain. Fabric upholstery should also be considered for comfort and noise control.

Manufacturers

a) *Godrej Interior*

We help create workspaces that are flexible, smart and intuitive. This not only ensures good health but also results in a stress-free environment and improved productivity.

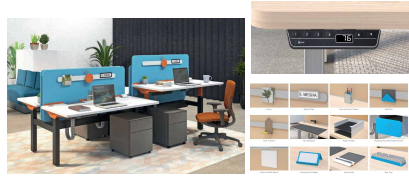











Furniture	Specifications	Materials	
Move up (keep moving, stay active)	Efficiency, comfort and well-being. Control with ease: Simple up-down controller. 4 pre-set memory controller with height display Bluetooth enabled controller	Particle board Ore-laminated particle boards Finishes: laminates	
Inter active solutions	A splash of activity to stimulate workplaces. They allow for sitting movement that strengthens your core and boosts blood flow while relieving pressure on your muscles and spine	Pocket / Bonnel Spring, Bonded Foam, Convulated Foam, Memory Foam, Latex & Coir.	
Habitat	Stackable, modular, and mobile It is possible to establish a variety of workspaces with little expense and effort thanks to Habitat's design of multipurpose spaces that are simple to build and reconfigure.	MDF for partitions and tiles Pinup tiles/boards foam (1mm/2mm), fabric Marker boards Glass/acrylic Steel clamps	

Table 1: Godrej Interior office furniture.

b) Feather Lite

Featherlite's primary area of competence is the production and sale of specialised office furniture that is both highly inventive and reasonably priced, including modular workstations, seats, partitions, desks, conference tables, and educational, laboratory, and retail furniture and fixtures.

Spaces	Layout	Products	Specifications	
Private spaces		Meeting pod	Acoustic Panels, 4 Seater or 6 Seater, Centre Table, Multiple Charging Points, Mounting Space For Television, Ports for easy connection to TV	
		Honeycomb focus zone	Acoustic panels, Return panel, Laminate main table, Multiple charging points	
Meeting spaces		Duo pouffle	Fabric upholsters pouffle, double seater, sturdy structure	
		Multiply	Acoustic panels, 120-degree module, seating/ main table/ shelving options	
Social spaces		Saddle pouffle	Fabric upholstered pouffle, unique style and design, rocking motion for constant movement	
		Portal	Acoustic panels, main high table, modesty panel for privacy	


		Interact	2 seater(per unit), acoustic panels, acrylic screens for privacy, fabric upholstered seating	
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Table 2: featherlite office furniture.

c) *Infiniti*

Furniture's	Materials
Table-tops / work-surfaces	Imported monolithic hard plastic Particle board Pre-laminated particle boards Finishes: laminates, membranes
Partitions (structure and legs)	Aluminum sections M.S sections Finishes: powder coating, chrome plating
Partitions (tiles and panels)	MDF for partitions and tiles Pinup tiles/boards foam (1mm/2mm), fabric Marker boards Magnetic boards Glass/acrylic Steel clamps

Table 3: Infiniti office furniture’s materials and finishes.

d) *Material Study Survey*

	Type	Thickness	Sizes	Processes / finishing	Companies
Acrylic solid (corian)	Plain white Textured	6mm, 22mm 6mm, 22mm	3680mm x 760mm 2500mm x 760mm	Sticking/sqft- 250 CNC cutting/ sqft- 350 Thermoforming/ sqft- 350	Corian, LG-Hausys, SAMSUNG-statron
Acrylic	Translucent				
Engineered stone		12mm, 15mm, 20mm, 30mm	3040mm x 1440mm 3040mm x 1650mm		Johnson crystal, LG-Hausys
Taclam			3000mm x 1200mm	Cutting	
Glass	Toughened Mirror lacquered	4,6,12mm 4,6mm		Sticking Glass cutting Thermoforming	

Particle board	Plain- interior grade, wood/ bagasse based	9mm, 12mm, 19mm, 25mm, 35mm	2440mm x 1220mm 2440mm x 1830mm 2745mm x 1830mm		
Laminates		0.6mm, 0.8mm, 1.0mm, 1.5mm	2440mm x 1220mm	Sticking Cutting	Greenlam, Sunmica
Ply boards	Marine BWR Grade	3, 4, 6, 9, 12, 16, 19, 25 mm	2440mm x 1220mm 2440mm x 920mm 2140mm x 1220mm 2140mm x 920mm 1840mm x 1220mm 1840mm x 920mm	Sticking Serving CNC Cutting	Century, Greenlam, Duro, kitpky, uniply, garnet, uro, virgo
	Commercial ply	3, 4, 6, 9, 12, 16, 19, 25 mm		Sticking Serving CNC Cutting	
	Pre-laminated	3, 4, 6, 9, 12, 16, 19, 25 mm			
Block boards	Marine grade	19mm, 25mm 30mm	2440mm x 1220mm 2440mm x 920mm 2140mm x 1220mm 2140mm x 920mm 1840mm x 1220mm		Century, Greenlam, Duro, kitpky, uniply, garnet, uro, virgo
Veneers	Without base panel, MDF/ ply base panel	3mm, 3.5mm, 4mm	2440mm x 1220mm		Century, Greenlam, Duro, kitpky, uniply, garnet, uro, virgo
Gypsum		9mm, 12mm	1800mm x 1200mm		

MDF	Interior, exterior, plain pre-laminated perforated	2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 19, 25, 30, 35 mm	2400mm x 1200 mm		
Honey-comb board	MDF/ pinewood internal, finish-laminate, veneer	Thickness from 30mm-100mm are available	2440mm x 1220mm		

Table 4: Different materials and its specifications (2022 data, U.P)

3) Design Criteria

When considering the size of the desks and tables, it's important to consider the number of people who will be working in the space. The size of the desks and tables should be large enough to accommodate all of the workers, but small enough to still provide an open and airy atmosphere. When it comes to the types of furniture, it's important to choose pieces that are comfortable and ergonomic, as well as aesthetically pleasing. The furniture should also be durable and easy to move around. It's also important to consider the storage solutions to be used, such as filing cabinets, shelves, and drawers. When it comes to the layout of the space, it's important to consider the flow of the space and how it will work for the workers. It's also important to consider the placement of the desks and tables to ensure that they are in the most efficient and comfortable positions. Finally, it's important to consider the lighting, noise levels, and ventilation of the workspace. Natural light should be maximized and the windows should be placed to let in the most natural light possible. The noise levels should be kept to a minimum, and the ventilation should be adequate to ensure that the space stays comfortable and healthy.

4) Trends

In recent years, the trend in open office furniture has been towards modular, multi-functional pieces that can be configured to fit any space. This includes height-adjustable desks and tables, lounge-style seating, and storage solutions that can be rearranged and moved around easily.

B. Questionnaires

A close-ended questionnaire was created and was sent to 5 different IT offices to collect data from employees regarding furniture design and flexibility in open office systems to improve the work environment.

Results from questionnaires:

- 1) Overall, the results from questionnaires suggest that employees rate the overall work environment in the open office system as good to excellent.
- 2) The majority of employees surveyed felt comfortable with the furniture arrangements in their open office space.
- 3) The majority of employees surveyed felt that the open office system provided them with sufficient privacy.
- 4) The majority of employees surveyed felt that the open office system allowed them to be productive.
- 5) The majority of employees surveyed were satisfied with the noise level in the open office system.
- 6) The majority of employees surveyed felt that the open office system encouraged collaboration.
- 7) Research findings show that the use of furniture in an open office environment is highly important to workers.
- 8) The type of furniture preferred for this environment is comfortable and adjustable seating, workstations, and storage options that can be easily accessed.
- 9) Workers also appreciate the flexibility of the furniture available in the open office environment, as it allows them to customize their workspace and adjust their furniture as needed.
- 10) Additionally, workers believe that the use of furniture in the open office environment can improve the environment by providing privacy, reducing noise, and increasing productivity.

- 11) The benefits of using furniture in the open office environment include improved comfort, increased productivity, better organization, and an improved work environment.
- 12) Popular types of furniture that work well in the open office environment include adjustable desks and chairs, storage cabinets, and standing desks.
- 13) The type of furniture that tends to not work well in the open office environment are those that are not adjustable and are often too large or too small for the space.
- 14) In order to improve the work environment and flexibility of the open office environment, workers suggest the use of adjustable furniture that can be adjusted to different heights and angles.
- 15) They also suggest the use of storage units that can be easily accessed and used to store items that are not in use.

III. CASE STUDY SELECTION

These two case studies were selected based on a flexible furniture arrangements in an office spaces showed the following results-

A. Microsoft Envisioning Center

This office is located in Redmond, United States with an area of 1556 ft². It was designed by Studio O+A in the year 2016.

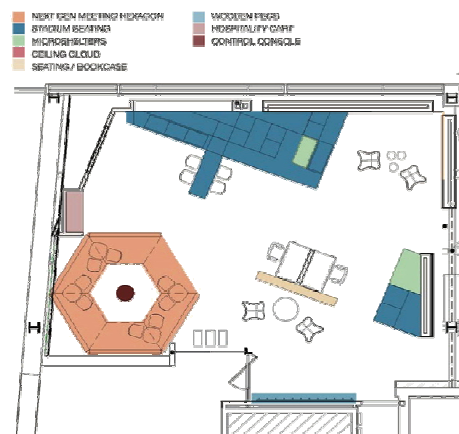


Fig 2: furniture layout



Fig 3: Seating/ bookcase



Fig 4: next-gen meeting hexagon



Fig 5: ceiling cloud

• Results

The Microsoft Envisioning Center is a research and design facility that focuses on exploring future technologies and design concepts. Here are some potential inferences that could be drawn from a case study on the center's work on furniture design and flexibility in open office spaces:

Flexible furniture can improve the functionality of open office spaces by allowing individuals and teams to adapt the layout of the space to suit their needs. This can be achieved through the use of anthropometric and ergonomic principles, which consider the physical characteristics and needs of the user in order to design furniture that is comfortable and efficient to use. Materials that are lightweight and easy to move, such as foam or plastic, can also contribute to the flexibility of the furniture.

Collaborative furniture, such as standing desks and modular seating, can encourage teamwork and communication in open office environments. These types of furniture often feature design elements that facilitate group interaction, such as circular or curved shapes, and may be made from materials that are conducive to collaboration, such as soft upholstery or whiteboard surfaces.

Well-designed furniture can enhance the aesthetics and appeal of open office spaces, making them more attractive to employees and visitors. This can be achieved through the use of materials and finishes that are visually appealing, as well as through the incorporation of design trends that reflect the company's branding and culture.

By incorporating ergonomic elements into furniture design, companies can help promote the health and well-being of their employees. This can include features such as adjustable heights, lumbar support, and ergonomically shaped seats and backs, which help to reduce the risk of musculoskeletal disorders and other common office injuries.

B. Cross Boundaries Office

Cross Boundaries office is located in Beijing, China with an area of 300 sq,mt, It was designed in the year 2021 by Binke Lenhardt, Hao Dong. This office is famous for its flexible or multifunctional spaces and modular furnitures.



Fig 6: Multifunctional spaces

(More than five activities and meetings –both formal and informal- can happen at the same time, providing a specific atmosphere for each communication process)

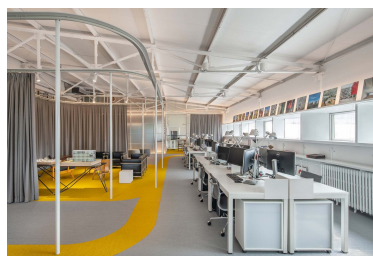


Fig 7: modular workstations

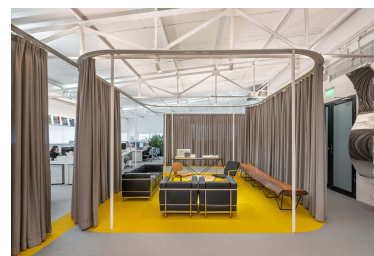


Fig 8: curtain rail

- **Result**

Cross Boundaries has successfully implemented flexible office designs that are adaptable to the changing needs of their clients through the use of modular furniture and partitions, as well as the incorporation of technology such as movable walls and smart devices. These design elements take into account the anthropometric and ergonomic needs of the user, as well as the flexibility and adaptability required in an open office environment.

The company's use of natural materials, such as wood and stone, and their incorporation of biophilic design elements, such as plants and natural lighting, have contributed to the creation of healthy, visually appealing open office spaces. These materials and design elements take into account the trends and preferences of the user, as well as the overall aesthetic of the space.

Cross Boundaries has demonstrated an ability to effectively blend traditional Chinese design elements with modern, western design trends, resulting in office spaces that are unique and culturally relevant. This can be achieved through the use of materials, patterns, and colors that are specific to Chinese design, as well as through the incorporation of traditional Chinese motifs and symbolism. By prioritizing the use of locally sourced materials and sustainable design practices, Cross Boundaries has helped to reduce the environmental impact of its projects. This includes the selection of materials that are sustainably harvested or recycled, as well as the implementation of energy-efficient technologies and systems. The company's focus on flexibility and adaptability has allowed them to successfully create open office spaces that meet the diverse needs of its clients. This includes the incorporation of ergonomic elements, such as adjustable furniture and technology, to promote the health and well-being of employees. These design criteria take into account the needs of the user and ensure that the furniture and technology are comfortable and efficient to use.

IV. FINDING AND RESULTS

- 1) *Anthropometry and Ergonomics*: In order to design furniture and a workspace that is both pleasant and effective, it is important to consider the physical needs and requirements of the user.
- 2) *Materials*: The selection of materials can impact the functionality, aesthetics, and sustainability of an open office space. Natural materials and biophilic elements can contribute to a healthy, visually appealing environment, while the use of locally sourced and sustainable materials can reduce the environmental impact of the space.
- 3) *Trends*: The incorporation of current design trends can enhance the appeal and relevance of an open office space, while also reflecting the company's branding and culture.
- 4) *Design Criteria*: The specific goals and needs of the company and its employees should be considered in the design process, in order to create an office space that is functional and adaptable to a variety of work styles and tasks. This can include the incorporation of technology and ergonomic elements, as well as the consideration of flexibility and adaptability.

V. CONCLUSION

The study found that flexibility in furniture in open office systems can have a positive effect on the work environment. It is important to consider the specific parameters that are important to the individual, such as personal comfort and work style preferences. Factors such as ergonomics, privacy, and noise levels should also be taken into account. Furthermore, it is also important to ensure that furniture is adjustable, modular, and easy to move, allowing for maximum flexibility. Based on the findings, a set of guidelines was created that can be used in open office systems to enhance flexibility and improve the work environment. These guidelines include creating an ergonomically sound workspace, providing adequate privacy, and ensuring that furniture is adjustable and can be easily moved. By following these guidelines, open office systems can be made more flexible and comfortable, resulting in a better work environment.

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