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Enhancing Building Design Strategies to Contribute in Wireless Communications

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Abstract—Wireless communication in building application and design currently act as two separate platforms of communication for inhabitants. Users utilize information sent and received through wireless technology unaffected by the space they are residing. As a means of data exchange and transfer objective information this method of communication serves its expected purpose. On the contrary in the case of personal communication, the surrounding space becomes an insignificant contributor. Also in a situation of wireless system failure the built space does not act as back-up support to all running functions. This paper questions the extensive reviews and is based on focus expert interviews (Qualitative methods) on building designs with specific objectives i.e. a) To allow building design to act as a backup for effective communication in case of wireless system failure b) To assess the building design for enhanced communication. For the purpose of data collection ten expert Architects were called for a focused group interview. The themes and sub themes from the focused group interview were assessed through thematic analysis and the results are discussed below in section VI.

Keywords—smart buildings, wireless, communication, backup, system failure

I. INTRODUCTION

The focus of architecture and interior design is not just to create spaces and forms but also to generate ‘communities’ , ‘enhance collaboration’ and ‘produce serendipitous encounters’. While designers focus on building regulations to create optimum spaces the upcoming aspect of wireless technology and smart systems needs to be taken into account [1][2].

The social advantages of reasonable structure are identified with enhancements in the personal satisfaction, wellbeing, also, prosperity. These advantages can be acknowledged at various levels – structures, the network, and society as a rule. At a structure level, examine on the human advantages of manageable plan has focused on three essential subjects: wellbeing, solace, and fulfillment. The structure condition can have both negative and positive effects on the tenants' quality of life.

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Negative effects incorporate diseases, truancy, weariness, inconvenience, stress, and interruptions because of poor indoor air quality, warm molding, lighting, and explicit parts of inside space structure (e.g., materials choices, goods, and work force densities). Diminishing these issues through reasonable plan regularly improves wellbeing and execution. Improved indoor air quality and expanded individual control of temperatures and ventilation have solid beneficial outcomes. Notwithstanding diminishing dangers and inconveniences, structures ought to likewise contain highlights and traits that make positive mental and social encounters. Albeit less investigate has been done on wellbeing advancing situations, rising proof shows that certain manageable structure highlights, including expanded individual command over indoor natural conditions, access to sunlight and perspectives, and association with nature, are probably going to produce positive conditions of prosperity and wellbeing.

At a network or cultural level, the social advantages of manageable plan incorporate information move, improved natural quality, neighborhood rebuilding, and decreased wellbeing dangers from contaminations related with building vitality use. Albeit more research has been directed on the advantages of maintainable structure highlights to building tenants, intrigue is developing in the network advantages of manageable plan [3].

This paper takes into account two types of public spaces namely office or workspace and hospitals or healthcare units. The criteria for this selection includes:

- Regular communication amongst inhabitants on daily basis.
- Large occupant size.
- Frequent exchange of data, content and information amongst participation.
- Monitoring requirements of patients and workers.
- Performance output of employees.

II. RESEARCH SIGNIFICANCE

Some of the attributes expected to be achieved through the use of wireless technology and smart systems and achieve efficiency are:

1. Integration

In this integration of smart systems into interior design facilitates easy functioning, operation of systems and minimizes the utility usage over the life span of the built area.

2. High Communication

The second attribute includes human to human, human to machine and machine to human communication which can take place both in the outside and interior world. In this way the building performs with a cloud network.

3. Adaptation with space

Another attribute allows flexibility of the system and space to adapt with the new changes.

4. Control over building systems

Lastly control over building functions and systems in order to maximize efficient use of energy while providing real time information of occupants. This includes taking into context their behavioral patterns and as a result proposing relevant smart lighting, smart materials and lighting [3].

The fig 1 shows a general categorization of public and private type of building which are either heavily dependent on wireless systems or gradually integrating them over years.

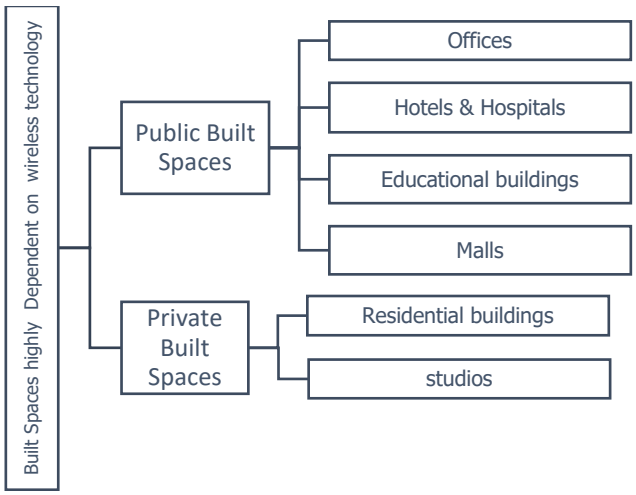

Fig. 1. Private and Public built spaces highly dependent on wireless technology

III. LITERATURE REVIEW

A. Application for patient well being in Medical Industry

A. S. Cifter et al describes how Hospital spatial designs are being developed with respect to new technology keeping in mind patient experience. Since information technology and databases have a key role in healthcare industry it is expected that it will improve communication between doctors and patients. An upcoming advancement in this regard is the telemedicine industry which allows patients to communicate with doctors via internet. Patients located at remote locations who do not access to good health care can communicate and receive feedback from doctors located in metropolitan cities. In this regard wireless technologies interference while designing the hospital building should be take into account [4].

Another advancement in this regard is as 'intelligent assistive environment' in which all interior elements such as toilet, bed, floor, walls, and tables act as a technological infrastructure. This provides real time information of patients to hospital management and staff and also decreases their work load. In this way patients can be in charge of many variables such as privacy, music lighting, air conditioning, heating etc. This allows them to create a soothing atmosphere with even options such as variation in ambient colors of lighting, intensity etc [4].

Although the advent of telemedicine has improved patient access to health care there are a few drawbacks such as:

- The disconnect between health professionals and the patients.
- Unclear conveyance of information regarding health.
- Other difficulties such as organizational issues.

In another study by Altaf Engineer et. al regarding how to promote logetivity in older adults through interior design habilitative design strategies are studied. These address the specific needs of users which are flexible and adaptive and include the integration of Internet of things (IoT) into living context. The article discusses technologies such as voice activated technologies, smart sensors and communication technologies. This allows elderly people or those with dementia or cognitive impairment can live independently or more conveniently under old age homes. They can easily take care of tasks such ordering groceries or controlling the temperature [5].

B. Application for Employee Communication in Workplace

Julie Wagner et. al discussed in 'Innovation Spaces: The New Design of Work 'how Internet of things (IoT) used in the working environment can broadly be categorized into three types:

- Infrastructure
- Repurposed smart home devices
- Business-specific IoT devices

Some of the broad trends which are changing how innovatively spaces are designed are:

- Replacement by smaller workstation devices such as laptops and tablets which are allow more mobility to employees and increases business output.
- Cloud technology in which data, software and other information is all collectively uploaded in a common platform. This has not though replaced the need of space by users [1].

The application of IoT and the people, things and services (IoPTS) has resulted into a disconnect between the employees in organizations and also results into a lack of quality in data exchange and can prove inaccurate with misunderstandings. Despite the fact that new there are advances in making technology seem more human-centric yet this does not fully replace the human oriented approach to work. Thus employee satisfaction, time management and organizational functioning are affected [5]. If the space connectivity parameters are planned simultaneously integrating with the wireless connection planning will result into creating a backup solution during wireless failure.

The following graph shows how communication can vary in a building from floor to floor based on its design.

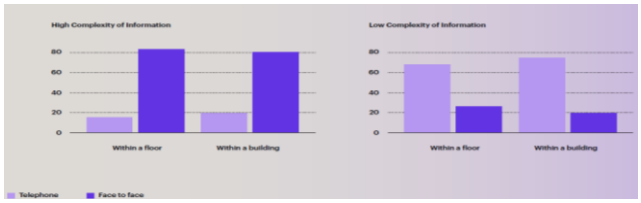

Fig. 2. Mode of Communication:Low complexity versus high complextiy of information [1].

IV. GUIDELINES FOR BUILDING DESIGN AS A BACK UP FOR WIRELESS SYSTEM SHUTDOWN AND ENHANCED COMMUNICATION

One aspect which is not prominent in buildings which have a heavy amount of wireless technology is the absence of 'coincidental meeting of humans' and more commonly termed as 'bumping into each other'. Certain classical and modern building design strategies if planned in tandem with wireless technologies can allow efficient work, clear communication and enhanced work and healthcare environment. The following building design guidelines are stated to provide an effective environment for:

- Hospitals using intelligent assistive environment.
- Workspace highly dependent on IoT & wireless systems.

Based on the following design spaces:

- Overall building design idea
- Courtyard planning
- Communal Spaces
- Nodal Axis
- Transitional Spaces
- Double height areas, atriums and over-looking galleries
- Internal Staircases
- Corridors
- Transparent building facade

C. Overall building design idea

In the fast moving age of technology and advancement, wireless systems have become a part parcel of our lives. This technology trend will has captured the construction market and increased dependency from building functions to product level [6]. In order to reduce such dependency building design solutions should be implemented however the design guidelines will vary according to purpose, occupancy, location, micro and macro climate, etc. Many primary and complex systems are based on wireless technologies however the design guidelines will address surveillance system backup.

Majority design guidelines can be referred from architectural history like courtyard planning, double height areas, skylights etc.

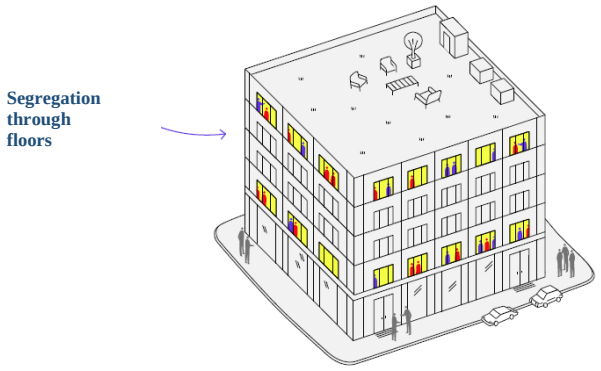

Fig. 3. Figure showing how workers on different floors will might not bump into each other in comparison to those working on the same floor [1].

D. Communal Spaces

Communal spaces are similar to courtyard spaces providing a common platform for people to work , sit and interact.

Fig. 4. Open floor layout enhancing a communal space model [7].

E. Courtyard Planning

Courtyard planning has been practiced from ancient times and the evidence can be seen in all historical buildings as shown in fig. 5. Courtyard planning in case of office planning will be helpful to have a common gathering point, however it may not be suitable in hot and humid climates but can be integrated with landscapes as passive strategy.

Fig. No 5 shows a typical layout for an office building with a courtyard design which allows diffused sunlight, visibility for employees on all floors and a green space for people to interact. [2]

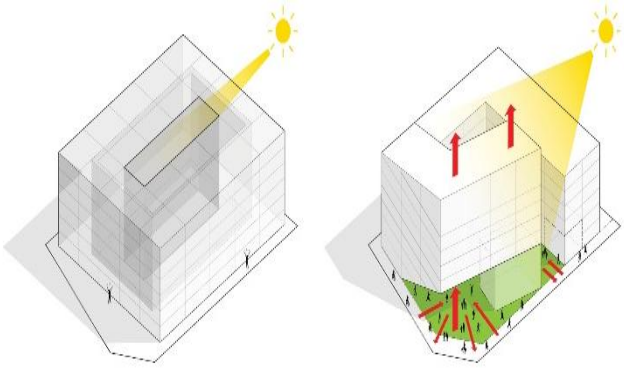

Fig. 5. Diagram showing a typical contemporary courtyard design [8].

F. Nodal Axis

Nodal Axis when incorporated in space planning provides connection zones called nodes between various spaces to interact and control.

G. Trasitional Spaces

A transition space is an essential feature of a building since they create both the movement around a built form and act as an entrance as well. The abstract and technical qualities are the key design features and generate an architectural perspective. The quality and design of a building necessarily requires transition spaces since they help in some create interesting visual spaces and other play a vital role in health and safety. The volume occupied by these spaces is a noteworthy aspect during design of a building [9] [10].

Many types of buildings include transition areas such as educational institutes, recreational spaces, offices and hospitals. The form of such spaces can vary to a great extent too. According to research the size of these areas can range from ten percent to forty five percent of the floor area. For example for an educational building 25% of the floor area may just be transition area. Although these areas are primarily used to generate spatial and visual design outcomes the importance of these spaces from an environmental point of view is relatively less. These areas might require unnecessary energy usage [9][10].

The figure below shows a plan view of well-designed interconnected transition spaces.

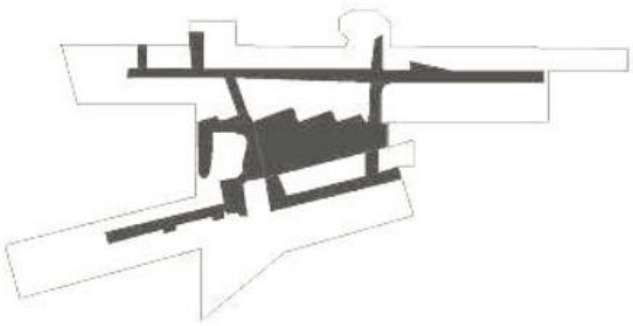

Fig. 6. Diagram showing a typical transition space in building [9] [10].

The figure no. 7 below shows a series of courtyards inspired from historical and current design methodologies.

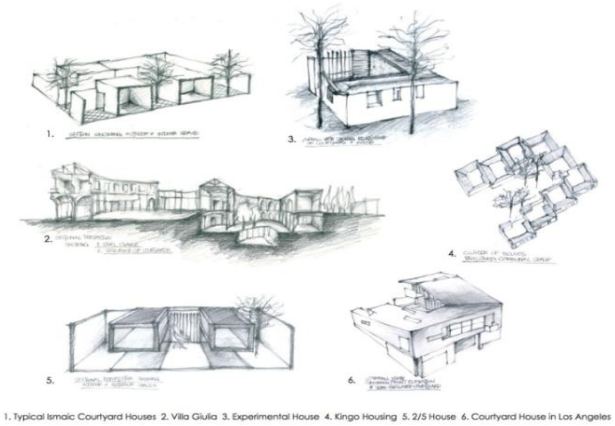

Fig. 7. Series of courtyard planning inspirations from past to present [7].

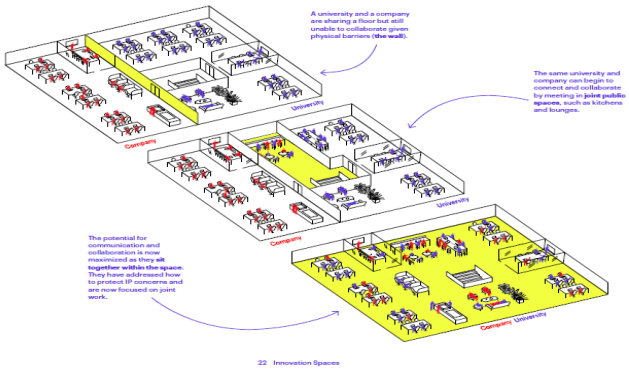

Fig. 8. Showing common transition spaces in buildings [1].

H. Double height areas,atriums and over-looking galleries

An atrium is a useful method for decreasing barriers across floors and allows a central core. It acts as a means to even out the building, provide daylight and enhance visual connectivity between areas. The design of the atrium and details in this case should act as a welcome connector.

Examples of atriums with maximum efficiency are seen in ancient cathedrals and churches has served surveillance purposes at public area as shown in fig. 9. Similar strategy when incorporated in design will create manned monitoring points in case of system failure. Public places like hospitals demand 24x7 surveillance and require backup planning [12].

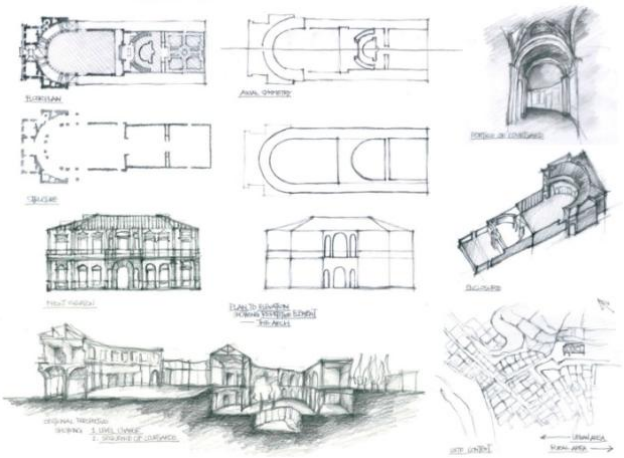

Fig. 9. Over looking galleries and double height areas as seen in cathedrals of rome [12].

When it comes to building design acting as back up for wireless system failures an atrium can allow a common space for team mixing on various floors at the same time. The focus of architects now is to apply spatial strategies which are creative in nature and allows a strong and seameless connect between people in a built space. Also these spaces allow enhance the effect of people physically mixing in a common space. As Tully Shelly who designed Stanford's Clark Center mentions that various spaces use different methods to facilitate connection of multi-disciplinary professionals such as clinicians, biologists, engineers, scientists etc. Other added precursors can also play a vital role such as seat placement etc. In the case of certain work areas pods or neighborhoods are created to enhance connectivity of researchers, discussion and dialogue [1].

This can also be done by having open work floor settings which also known as 'new legibility of landscape' is allowing people to involve in talks and conversations. This can range from incubator spaces to maker spaces to an open floor layout. In this way managers are bringing down physical obstructions which damper mixing and collaboration. An example of this is Clark Center in Stanford where twenty two different group formations can be created by this approach [16].

I. Internal Staircases

A very classic architectural design strategy is to use a grand central staircase. This design strategy with the advent of elevators has shifted staircases to the edge of the floor plates of the building and requires to be brought back to its traditional style. This will allow an aesthetic and noticeable aspect and allow people to interact while moving through spaces. More simply described as a means of bumping into each other [14].

J. Corridors

A strategy for circulation in which corridors are spatially redesigned to allow people to connect more easily is the use of corridors. This can allow serendipitous encounters. An example of this can be seen in Sheffield and St. Louis where corridors connect to a central space allowing people to circulate through it. The use of corridors can help funnel people into required zones and reduce noise

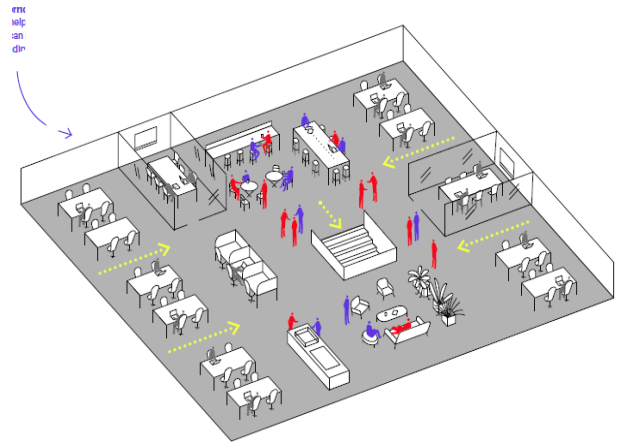

Fig. 10. Figure showing internal corridor like layouts [1].

K. Transparent Building Façade

A transparent building façade gives access through its out skin to monitor its services from external source. In case of in-house wireless failures, public systems can act as a backup to monitor and provides a backup system.

The guidelines listed above are dependent on various conditions and can be considered as generic. These guidelines reminds us of our basic building design and history studies with are very simple but act as a solutions to many complex problems.

V. UPLIFTING HUMANISTIC COMMUNICATION THROUGH BUILDING DESIGN WITH REDUCEDS DEPENDENCY ON WIRELESS TECHNOLOGY

Cities become more livable with technological applications and it helps usher sense of safety with an effective functioning infrastructure, economic health, affordability, green space, and natural and cultural assets. These technical boons can also foment adverse effects like pollutions, sprawl, and good or bad connectivity. What it cannot do is take the place of the vital relationship that people have with one another, their communities, and their Built environment [18].

Effective communication is needed at many unplanned situations to serve purpose like inform, connect, control, and allows for emotive expression. Human beings have created a dependency on creating cohesion and connection on wireless connectivity. It is very natural to face limitations of physical devices, IOT systems face device-level issues such as battery power drainage, limited memory, technical hitch, limited processing power of small devices, device management downtime.

VI. RESULTS AND DISCUSSION

The focus expert interviews on building design as sustainable back-up strategy as a means to enhance the wireless technologies and communication was broken down to two specific themes via the method of thematic analysis and results are shared in Table 1 below.

Table 1: Results of Thematic analysis of focus group interview

SUBTHEMES	CONCEPT	THEME
Sustainable architecture systems are being executed out in the open structure plans. While cost is constantly a top thought for city building organizers, it is often that spending more forthcoming on economical techniques can give enormous investment funds after some time, yet additionally decidedly sway air quality, prosperity, and lead to a regenerative future [22].	Maintainable structure plan and development and Building Design as a sustainable Back-up strategy is the act of making structures and utilizing forms that are earth mindful and asset effective for the duration of the existence cycle of a structure from choosing the site to structure, development, activity, support, remodel, lastly, deconstruction [23].	Feasible structure develops and supplements the traditional structure plan contemplations of economy, utility, sturdiness, and solace. Different expressions for economical structure incorporate green structure, superior structure, or practical or green development. [22].
Mental impacts (e.g., solace, fulfillment and prosperity) are created through perceptual also, tactile procedures that decipher ecological data regarding its impact on current requirements, exercises, and inclinations. The mental "understanding" of the earth has ramifications for work execution and efficiency (as talked about in Section 2.6), stress, and prosperity. Due to the inborn fluctuation in mental reactions, the equivalent ecological conditions can influence various individuals in various manners just as influence a similar individual in an unexpected way after some time, contingent upon the specific situation.	Tenant solace and fulfillment with building conditions are an essential focal point of post-inhabitance assessments. The exploration for the most part shows that inhabitants' fulfillment with lighting and air quality is higher than their warm and acoustic fulfillment (Leaman and Bordass 2001). Endeavors to improve solace and fulfillment are significant on the grounds that distress has negative ramifications for work viability, work fulfillment, and nature of work life.	Certain structure highlights, for example, sunshine, sees, association with nature, and spaces for social communication, seem to have positive mental and social advantages. The advantages incorporate decreased pressure, improved enthusiastic working, expanded correspondence and an improved feeling of having a place.

VII. CONCLUSION

In this paper various building design systems that has been seamlessly integrated to wireless technology has been discussed. The complexity of Building design systems varies on its type and character which can be private or public. In today's time the dependency on Internet of Things as a connecting tool has been absorbed by all designers and tech engineers in their overall processes. This is resulting into an increase in the dependency on such systems which can prove fatal in case of system failures and lead to various casualties.

It is recommended that all buildings, especially public buildings should always have a backup which is independent of all these wireless networks. Public buildings like hospitals demand surveillance at all times to avoid any casualties, patient escapes, control public access etc whereas in office buildings data thefts and illegal misconducts are few to be named of. Integrating design strategies can act as backups for such times and provide a breather to troubleshoot the systems. There is plenty to learn from our ancestors who lived their life without the benefit of any such technological luxury.

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Banafsha Quadri Rajput, LEED Green Associate holds Master's degree in Architecture (M. Arch). Her work experience caters wide range from industry practice, Green building projects, training & course delivery. Currently she faculty & Program Leader for BID & MID at Amity University Dubai for School of Architecture - Interior Design since 2014. Her involvement includes various teaching learning programs at undergraduate level. An innovative personality who has been mentor to students at various design platforms & incubation startup.

Amna Rafi Chaudhry, graduated as a Landscape Architect from Harvard University, USA in 2012. Harvard design studios and courses are heavily focused on principles of landscape urbanism. The aim is to generate landscape strategies that work in tandem with the multiple layers of social, economic and sustainable growth of cities. She has applied this ideology for the past ten years of practice in academics and industry. Her projects are largely centered around sustainable master planning, strengthening public realm and reducing carbon footprint through landscape systems. Currently she is pursuing research on pressing topics pertaining to the role of landscape architecture in urban development.

Dr. Sonakshi Ruhela, is currently designated as the Head of Academics- Humanities, Arts and Applied Sciences at Amity University, Dubai Campus. She is the recipient of the 'Academic Leadership Award' by GISR Foundation in 2019, the "Best Paper " award at the International Conference on Current Practices & Future Trends in Media Communication in 2019 and the 'Outstanding achievement for Autism Awareness' award by Child Early Intervention and Medical Centre and Maharat Learning center, UAE in 2018. She has participated in over 50 Corporate Talks, Career Fairs, Community Awareness programs, Women Development & Empowerment Programs, School Development Initiatives and Health and sports initiatives. She has a proven an outstanding track record for the last 11 years of being an effective communicator in the ever changing world of education, research and technology in which the tussle between traditional and contemporary pedagogical methods continues.