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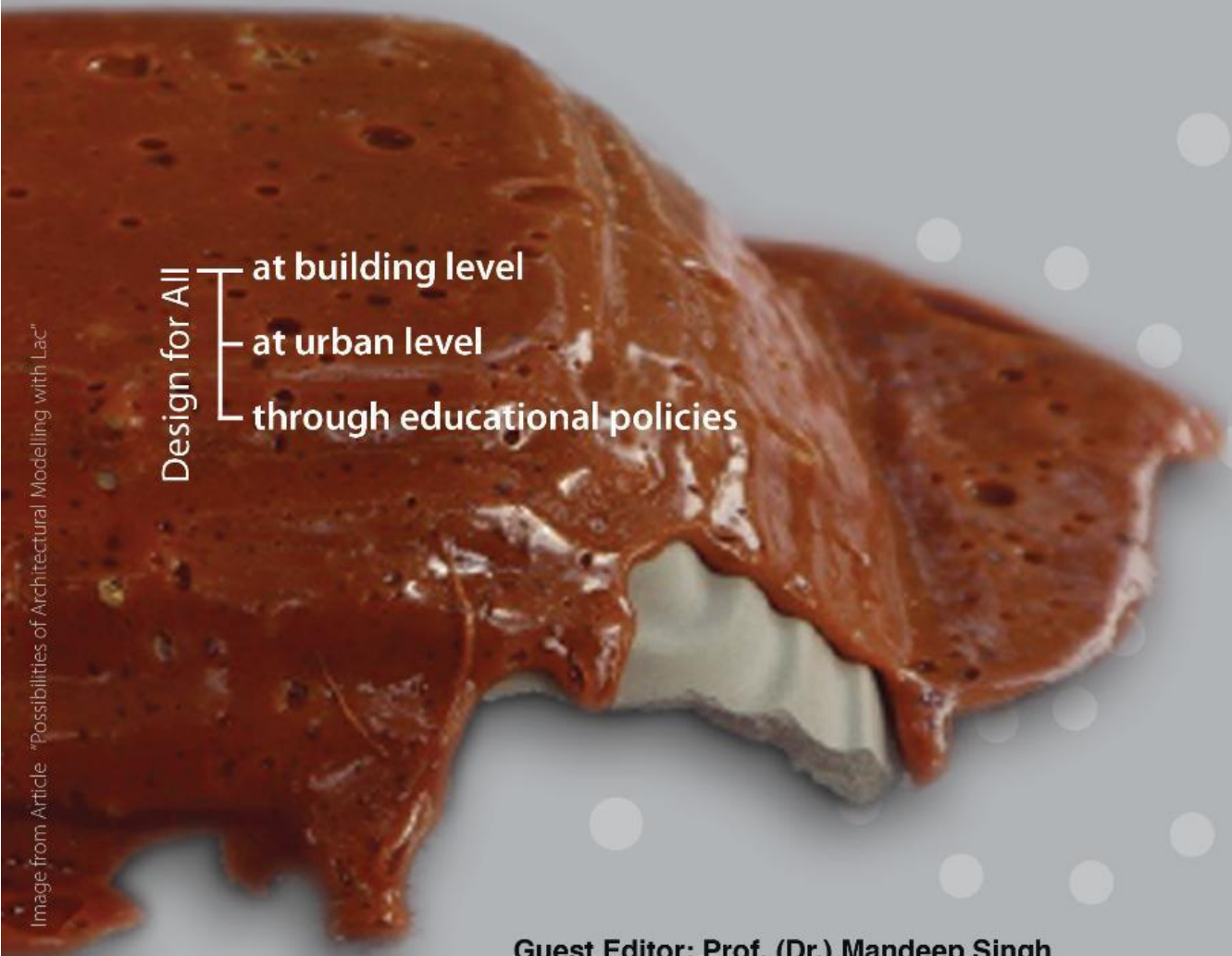

Image from Article "Possibilities of Architectural Modelling with Lac"

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GUEST EDITOR:

***Prof. (Dr.) Mandeep Singh** is presently Head Industrial Design Department and has been Head Architecture (2014-15 & 18-19), Dean of Studies (2015-17), Head Urban Design (2011-14) Head Industrial Design (2005-10), apart from being a full-time faculty at the School of Planning and Architecture, New Delhi since 1986.*

In addition to teaching, guiding design and research projects for 35 years, Prof. Singh is currently serving in several committees set up by the Government of India. He is a Member of Delhi Urban Arts Commission, Advisor to Association of Indian Universities (AIU), Advisor to Competition Commission of India (CCI), Member of Project Steering Committee (PSC) for 'Developing Energy Efficient Building Material Directory', Bureau of Energy Efficiency, Professional Advisor for National War Memorial, Ministry of Defence, Advisor and Member, Governing Council, NID Haryana, Department of Industrial Policy and Promotion, Ministry of Commerce and Industry, Jury Member in the Committee for National War Museum, Ministry of Defence, and Member of Expert Committee for selection of tableaux for Republic Day Parade, Ministry of Defence.

He has been consultant, advisor and peer reviewer to many public and private sector organisations, notable being World Bank, CPWD, Shri Mata Vaishno Devi Shrine Board, Reliance Infrastructure, Ministry of Defence for National War Memorial

Competition, Competition Commission of India, Basmati Export Development Foundation, Golchha Organization (Nepal), Bureau of Police Research and Development (BPRD) for creating identity of Police Station and conducting architectural competition among others.

Prof. Singh has vast experience in guiding PhD scholars, and numerous publications to his credit.

Guest Editor's note

I have been at the School of Planning and Architecture (SPA), New Delhi as faculty for over 35 years and if we add my student's years, it is around 48 years of being in SPA to experience its evolution. SPA Delhi was established in 1941 and grew from a Department of Architecture of Delhi Polytechnic to being recognised as "An Institute of National Importance under an Act of Parliament" in 2015.

Everyone at SPA Delhi, including students and faculty of ten graduate and two undergraduate departments of Architecture, Design, Planning, Landscape and Management among others, work on different aspects of 'Design for All'. The theme is embedded in the style of thinking, teaching, and learning across board.

This volume and compendium of papers provides views of young faculty and scholars on design for all at the building level, urban scale and at the policy level. All scholars and authors are associated with SPA Delhi, which is the knowledge partner with Design for All Institute of India for this peer reviewed edition of the journal.

The first five papers reflect upon various issues around design for all at the building level. Ar. Himanshu Yogi explores the possibility of using lac in of architectural modelling. His study reveals that casting, injection moulding, and 3D printing of architectural models are feasible with lac and recommends further investigation for other applications. Ar. Priyanka Kochhar delves into the incremental costs of green buildings that are instrumental in mitigating the impacts of climate change. Her paper identifies

the incremental cost and evaluates the role of various government incentives in offsetting additional costs towards green residential developments. Ar. Niyati Gupta has identified the key resilience indicators featuring barrier-free design and planning actions for new construction of medium and large-scale hospital buildings with more than 100-bed capacity. The outcomes of her paper aim to help construction professionals make resilient hospital buildings. Ar. Parul Nayar has proposed five parameters to provide unique architectural design solutions required for the successful functioning of a mixed-use facility for senior living. The parameters have been used to study and analyze the Parkside Retirement Homes in Bangalore and House of Generations in Denmark. Recommendations of the analysis, which may be used by architects at large have been integrated in the design of a potential senior living facility, as a part of an undergraduate thesis project. Ar. Gunjan Jain investigates futuristic material-oriented design approach in generating forms. The paper concludes with a discussion on the potential and challenges of the material-oriented design approach along with the possibility of taking it up on a large scale.

The second set of five papers focus on issues around design for all at the urban level. Ar. Sonika Sehrawat has reviewed literature published over the last decade around 'inclusion and built environment'. Through extensive analysis, her paper concludes that most literature on the subject is focused on minimum standards and inclusive design is yet to incorporate innovative solutions, even in developed countries. Ar. Vandini Mehta has investigated specific urban histories of Karol Bagh-Western Extensions and Imperial New Delhi, to re-examine and historicise the ways in which inequity is created and maintained in our cities even today. Ar. Trishla Chadha emphasises on the need to create

spaces that evoke-affect-inspire people through physical and digital interventions. With an aim to integrate technology and urban development, the paper proposes a digital app based on an algorithm identifying the parameters contributing towards the direct impact and the perception of safety.

Prof. Advaita Jalan focuses on the role of form-based codes as determinants in reclaiming threshold spaces and concludes that form-based codes play a critical role in arriving at context-specific response to reclaim threshold spaces within the walled city of Vadodara. Ar. Kamini Singh investigates the impact of the outdoor surfaces' materials, accessibility and thermal properties on the user choice and selection for performing outdoor activities in high-rise residential environment of Greater Noida. The paper concludes that user preference for outdoor residential spaces is closely determined by the thermal comfort and accessibility, however there is a pattern with respect to age, gender and activity level of each user group.

The third and last set of two papers suggest educational and policy level interventions to facilitate design for all. Ar. Shalini Raman Vig focuses on identifying the need to evaluate and contextualize guidelines and policies that inform space design solutions pertaining to home hospitalization in urban residential environments. The paper takes an integrated look into the domain of home hospitalization in urban Indian context along with reference to global trends. It concludes with highlighting the need for identification and evaluation of guidelines and policies in the evolving domain for development of requisite space design and planning benchmarks. Ar. Raja Singh discusses the pedagogy and other techniques for teaching accessible design to architecture students. Using emotionally charged pedagogical exercises, the

author has been able to sensitize students of architecture towards Universally Accessible Design, which is reflected and validated through an anonymous and optional survey.

These papers have been checked for plagiarism and have gone through a peer review process. Prof. (Dr.) Anil Dewan, Head, Department of Architecture, Prof. (Dr.) Sewa Ram, PhD Coordinator and Head, Department of Transport Planning and Prof. (Dr.) Ashok Kumar, Dean (Academics) have been part of the peer review committee.

As the Guest Editor, I am grateful to Prof. (Dr.) P.S.N. Rao, Director SPA Delhi for accepting the proposition for SPA Delhi to be the knowledge partner on this issue of the journal. I appreciate inputs provided by Ms. Aditi Singh and Ms. Priyanka Kochhar, PhD scholars at SPA Delhi towards compilation of this edition.

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Trained as an Industrial Designer and an Architect, Himanshu Yogi received his Master's degree in Industrial Design and Bachelors in Architecture from the School of Planning & Architecture, Delhi in 2019.

His current work involves the human-centric approach, integrated with sustainable principles to develop design iterations in Branding & Packaging, Healthcare & Lifestyle Design and Manufacturing with green materials.

His keen interest in regional handicrafts led him to explore traditional manufacturing techniques and materials.

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Parag Anand has a Master's Degree in Design from IIT, Delhi. He has been trained at the Delft University of Technology, The Netherlands and worked with Dr. Ab Stevels of Philips Eindhoven, one of the pioneers of the concept of Eco-Design.

His design experience of more than two decades spans fields of Product, System and Communication Design. As a keen academician with interests ranging from System to Social Design, he is also visiting faculty at various institutions like IIT Delhi and RMIT Melbourne as design mentor.

Ar. Aditi Singh, Assistant Professor

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Aditi Singh is an Industrial Designer and Architect with extensive experience in fields of product design and innovation, sustainable systems design and next-gen experience design. A two-time recipient of the prestigious international Red Dot Design Award, her diverse award-winning work has been interdisciplinary in nature, blurring boundaries between various design disciplines.

With a keen interest in academics and research, she has been actively associated with premier institutes and agencies, including the Gates Foundation, RMIT University, Melbourne, Australia and the IITs. Currently, in the dual role of a Doctoral Scholar at RMIT Melbourne and as Assistant Professor at the Department of Industrial Design, School of Planning and Architecture, New Delhi, she is involved in a variety of research and design projects with a passion towards the intersection of the digital and physical space, and the joy in building human connections with design.

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Possibilities of Architectural Modelling with Lac

Theme: Encouraging usage of natural resins like lac in prototyping

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Abstract: Plastics are widely used in architectural modelling, be it acrylic sheets stacked together to form block models or a 3D printed sectional model made out of plastic filaments. Although with the raising concerns about plastic waste, the focus is shifting on encouraging bio-degradable plastics. In these circumstances, Natural resins have emerged as a substitute to conventional plastics. The knowledge of natural plastics or resins is known since ages and one of these natural resins is Lac. In India, Lac is a general term for the products of resinous secretions from Lac beetle. Lac as a material has low embodied energy and can also be reused in manufacturing applications for its thermoplastic properties.

The study is intended to investigate the types of architectural modelling & model making materials and further exploring possibilities of using lac in modelling. The sustainability of the material is assessed by analysing its physical and chemical attributes. Further, hands-on methods and experiments were applied to Lac to check its suitability for architectural modelling. The study reveals that casting, injection moulding, and 3D printing are feasible with lac. Other applications in architectural modelling using lac as a material can be further investigated.

KEYWORDS: ***Lac, Natural Resin, Modelling, Manufacturing, Sustainability***

Introduction

In design practice, process of design has given more emphasis than the end result. This entire process involves stages of understanding the context, ideation of concepts, prototyping and design development. As a designer, focus is given for a sustainable design for the benefit of the community and the environment. Whereas the prototyping stage that involves modelling of various stages, generates lots of non-recyclable waste. Hence, tagging this prototyping process as unsustainable.

Currently, model making has been classified in two ways, namely, Subtractive and Additive modelling. Subtractive modelling involves sculpting out material to get the desired form whereas additive modelling is done by adding different layers on each other to produce the form. Although the subtractive modelling creates more waste but the materials used in both ways aren't reusable to make new models.

Lac is a natural resin whose jewellery products of Jaipur, Hyderabad and Patna are very popular handicraft. The bangle makers melt the lac and mix it with stone dust and prepare a sticky paste to produce bangle sticks. These sticks are folded around a wooden cylindrical mould to give the shape of a bangle. The process of melting and making lac bangles is similar to clay modelling added with heating. The thermoplastic properties of lac enable it to be reused again by heating it. This allows bangle makers to make corrections if something goes wrong. Also, lac being a food-grade material doesn't release any harmful fumes. Hence lac has a promising prospect, of being used as an eco-friendly alternative material for modelling & prototyping.

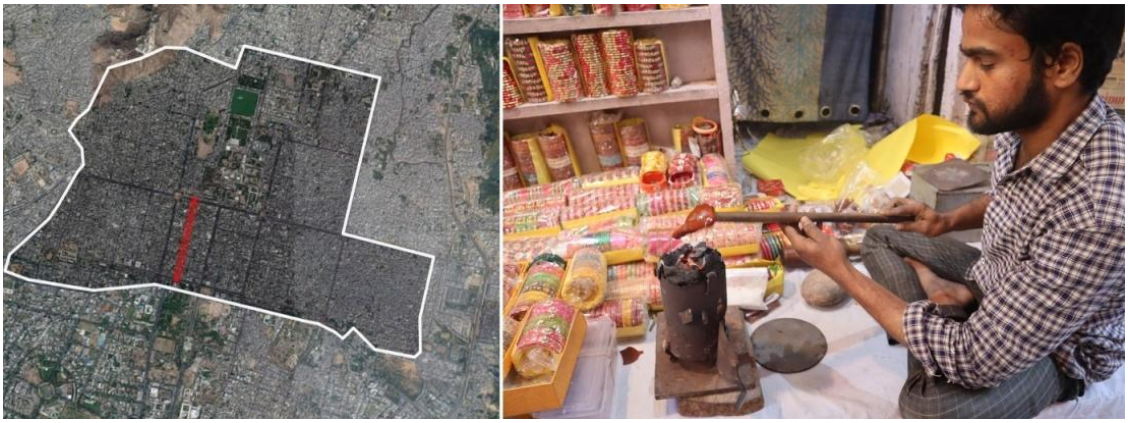

Figure 1:Red marked "Maniharon ka Rasta" street for lac bangles in walled city, Jaipur, and artisans working with lac. (Left to right)

Architectural Modelling

It is an essential tool that helps an architect from design's conception to the completion stage. A 3D model is a must to understand the design in wholesome way and a physical model is the best way to convey design concepts.

In the case of architecture where one can see the product only after its completion, model making bears extreme relevance. These models not just help in visualization but they are also required during design development stages. Through these models an architect gets to understand, analyse, revisit and further refine their design.

Modelling helps in better understanding of the composition of form, proportions, materials, colours and textures. They provide an opportunity to develop and explore the relationship between the open & built spaces and unlocks the prospect to play with colours, textures and materials.

Figure 2: Design discussion through model (Urban Design Studio, SPA Delhi 2014)

Architectural Modelling: Earlier

Before the advent of 3D development and rendering softwares, physical models were the only medium for architects to represent their creative ideas in three dimensions. The art of modelling has also evolved with the arrival of new materials and manufacturing techniques. Earlier models were handcrafted out of wood, stone, clay and plaster. As these models were meant for presentation before kings and nobles, it was frequently tried to mimic the actual structure by using similar colours and textures.

Architectural Modelling: Nowadays

In the digital age where one can visualize designs with the help of 3D software, physical models haven't lost their relevance. It's the very tangible aspect of physical models that provide the opportunity of exploration in a more rigorous manner in comparison to its digital counterparts.

Nowadays, a variety of materials and manufacturing techniques are used to make a model, while considering the availability of budget & time. Casting, hot wire cutting, laser cutting and 3D printing are few techniques that are currently used with the materials like paper, wood, plastics, resins and many more.

Planning for Modelling

Determining the scale and detailing required, are the first step in deciding the material and techniques to be used in modelling. Once the material is selected, a strategy is formed that requires less time duration, minimum cost and ease of modelling. Time, cost and labour are the major parameters in determining a manufacturing technique for making a nice and informative architectural model. Even while selecting a material, it isn't necessary to stick with just one type of material. Often designers use a combination of two-three materials, best suited to the composition and objective of modelling.

Objective of Modelling

A three-dimensional model serves a variety of purpose. It could be a conceptual model made during development stages or a presentation model created to explain the design. Depending upon the architect's objective to communicate their design, models can be classified into following categories.

Figure 3:Different types of models. Interior model (Top three), Sectional & Zoom-in model (Middle left), Site Model (Middle right), Structural & façade Model (Bottom six)

Block Models

A Block Model represents the massing, scale and proportion of a design. Instead of providing the detailed information, these types of models give a simplified idea of various components of a design. It is an efficient tool to take any on-spot design decisions and refine a raw concept. Such models are easier to make and enables a designer to explore a variety of concepts without worrying about details related to material, construction and structure.

One more benefit of Block Models is that a variety of materials can be used to make them. As the primary objective of this type of modelling is to study the form of design, so there's no requirement to mimic the final design's materials. This type of prototyping is used to examine how different components of a design are functioning together and along with its immediate context.

Site Models

"How we approach a building?" is an important aspect of Design. Site Models comes handy in understanding the circulation around the site and design's relation with the context. After conceiving the form, Site Model is the next step in design detailing considering the immediate surroundings of the structure. Site model is used to study the effects of new structure in the existing urban sprawl.

As the objective of Site Models is to study the relation between new design and the context, the scale of the design reduces to a simplified block model, purely representing the design without any unnecessary details. Omitting these details lets the designers

to focus on the design without getting involved in rigours detailing. Depending upon the scale and size, contrasting materials or colours are used to highlight the new design in its surrounding context. These types of models help the designers in understanding the movement patterns, topography, natural and man-made features around the site on urban level. Therefore, it is widely used in explaining urban design, landscape design, transport-hub design, campus design and mass housings.

Zoom-in/Part Models

They are all about detailing and explaining the intricacies of a design. As per the scale of a given design proposal, zoom-in models are used for both detail development and understanding the working of any detail. These models also help in on-site execution of these details. The need to examine a detail, leads to these models being built on a scale of 1:20, 1:10, 1:5 or in case of working prototypes it could be as big as 1:1 scale. As the scale of the design increase, focus shift on using or presenting the actual materials, colours & textures. Therefore, it is widely used in explaining interior & exterior design, furniture design, product design, joinery or fixing details or any other details required for execution on site.

Structural Models

They are characterised by their skeletal appearance and help in understanding the assembly of a framework and explaining the structural system of a design. Throughout the design development process, structural models aid in backing the raw concepts and ideas by providing the structural validation to them. As compared to their digital counterparts, the physical models help in pinpointing the issues, which may not appear in CAD models. For architects, these models are really useful in comprehending how

various elements of structural design are supporting and fitting together and innovating these elements as per their design concepts.

Sectional Models

Emphasising on sections while design development process has a direct impact on the spatial quality of a design. Sectional models are a great tool to understand a design that involves built spaces on different levels. Depending upon the scale and size, sectional models are a perfect tool to understand the spatial relationship around or within the built spaces. At the same time, it also demonstrates the structural framework of a built-up cut through that section line. Section models sizes can vary from zoom-in model to site models providing the insights to a designer that eventually help in three-dimensional modelling.

Material Selection

This plays a pivotal role in architectural modelling. It provides the opportunity to explore and materialize the concepts into final design. Through modelling, selection of material colour palette becomes easier by trying different compositions on it. After finalizing the material, the next step is to decide a suitable manufacturing technique. Here are the most commonly used model making materials and the techniques, analysed on the parameters of Time, Cost & Labour and End-of-Life of these models.

Paper & Cardboard

Technique applied	Time, Cost & Labour	End-of-Life
Hand cutting	More time & labour but less cost	• Models once made can't be reused but paper can be recycled. • Although paper is an organic material so it will degrade without polluting the ground.
Laser cutting	Less time & labour but more cost	
Pasting or Assembly	Done manually	
Colour & finish	Available in different colours and textures and printing is also feasible.	

Wood/MDF/HDF

Technique applied	Time, Cost & Labour	End-of-Life
Hand cutting	More time & labour but less cost	• Models once made can't be reused again and but wood can be recycled. • Wood is an organic material so it will degrade without polluting the ground.
Laser cutting	Less time & labour but more cost	
Sanding	More time & labour but less cost	
Pasting or Assembly	Done manually	
Colour & finish	Available in different shades of brown and have variety of grains and etching via laser cutting is possible.	

Natural clay or plasticine

Technique applied	Time, Cost & Labour	End-of-Life
Hand modelling & sculpting	More time but easier to make and one time cost for sculpting tools	• Models once made from natural clay can't be reused

Wire/thread cutting	**Easier to cut straight edges, nothing significant in terms of time & cost**	**again and it usually ends up in dump yard.**
Casting	**Involves extra time, cost & labour for development of moulds. Once done models need time to get dry**	• **If not baked, plasticine models can be reused again.**
Colour & finish	**Available in different shades of brown, whereas plasticine has variety of colours and both of them have smooth matte finish.**	

Plaster of Paris (POP)

Technique applied	Time, Cost & Labour	End-of-Life
Hand modelling & sculpting	**More time but easier to make and one time cost for sculpting tools**	• **Models once made can't be reused again and it usually ends up in dump yard.**
Wire/thread cutting	**When wet it's easier to cut straight edges, nothing significant in terms of time & cost.**	
Casting	**Involves extra time, cost & labour for development of moulds. Once done models need time to get dry. Good for multiple repetitive models.**	
Colour & finish	**Has a light grey colour but we can try and mix different colours in it and it has a smooth matte finish.**	

Acrylic Sheet

Technique applied	Time, Cost & Labour	End-of-Life
Laser cutting	**Less time & labour but more cost**	• **Models once made can't be reused again and it usually ends up in dump yard.**
Pasting or	**Done manually**	

Assembly		• **Acrylic is a type 7 non-biodegradable plastic.**
Colour & finish	**A variety of colours & transparency and available in both glossy & matte finishes.**	• **Can be recycled but segregation is difficult.**

Polystyrene

Technique applied	Time, Cost & Labour	End-of-Life
Hand modelling & sculpting	**More time but easier to make and one time cost for sculpting tools**	• **Models once made can't be reused again and it usually ends up in dump yard.**
Wire/thread cutting	**When wet it's easier to cut straight edges, nothing significant in terms of time & cost**	• **Polystyrene is a type 6 plastic and it isn't a bio-degradable plastic.**
Pasting or Assembly	**Done manually**	• **Recycling of Polystyrene isn't feasible, as it is cheaper to produce and hard to collect.**
Colour & finish	**Produced in 2-3 different shades such as blue, white, pink and yellow and it has a matt**	

PLA, ABS & Nylon Filaments

Technique applied	Time, Cost & Labour	End-of-Life
FDM 3D printing	**More time, easier to make and expensive method**	• **Models once made can't be reused again.**
Pasting or Assembly	**Done manually**	• **The most commonly used materials in FDM 3D printing are PLA, ABS & NYLON**
Colour & finish	**Filaments can have a variety of colours and the model bears a**	• **PLA is a bio-plastic, hence, it degrades easily in**

	layered texture of additive printing.	**controlled environment.** • **All of these materials are thermoplastics hence, they are recyclable.**

Material Analysis

- ***The cost of model making is inversely proportional to time and labour. As the cost increases, time and labour decreases.***
- ***Except plasticine, none of the materials can be reused to make new models.***
- ***Being an organic material paper, wood and natural clay don't have any adverse effect on the soil and it gradually degrades.***
- ***Whereas acrylic sheets, polystyrene and 3D printed models of ABS & Nylon aren't bio-degradable and remain intact for decades.***
- ***Thermoplastic properties of PLA, ABS and Nylon enable them to be recycled again but it requires more than 150°C for melting.***
- ***The fumes generated while laser cutting of plastics and organic materials such as paper and wood is unpleasant and toxic. A prolonged exposure to these fumes has harmful effects on human health.[1]***
- ***The Fused Deposition Modelling (FDM) type of 3D Printing involves melting of filaments at temperature more than 150 °C, which generates harmful fumes.[2]***

[1](R. J. Roach 1998), R. J. Roach, E. A. Raymond, J. R. Tyrer, and B. L. Sharp. 1998. "The indexed assessment of fumes generated by high power laser material processing." Journal of Laser Applications Volume 10, Issue 3 (1998).
[2](Singh 2017), Singh, Neelam Bharti and Shailendra. 2017. "Three-Dimensional (3D) Printers in Libraries: Perspective and Preliminary Safety Analysis." Journal of Chemical Education 2017 94 (7) 879-885.

Understanding Lac

In India, Lac is a general term for products of resinous secretions from Laccifer Lacca beetle, both before and after various stages of its refinement. Refined lac is also known as Shellac and raw lac as Stick Lac.

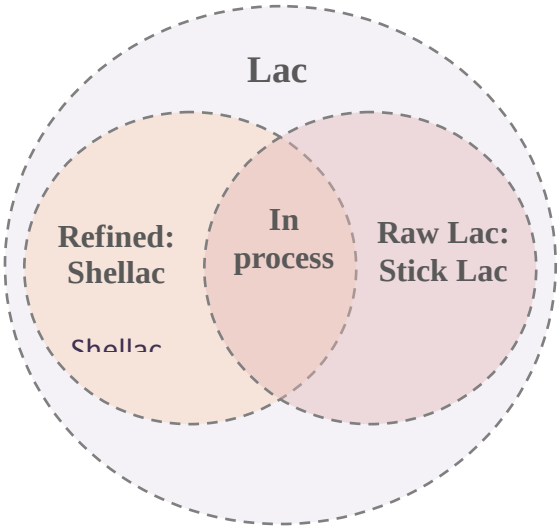

Figure 4: Lac as a general term

Lac is known to Indians from since decades. Its usage as sealing an envelope and as a stamp is still common in various parts of the subcontinent. A brief account about the medicinal and cosmetic qualities of lac has been mentioned in ayurvedic books of Atharva-Veda, Charak & Sushrut Samhita.[3] These common reference shows a familiarity with resin and its uses within the community.

Nomenclature

The word *Lac* is itself derived from the Sanskrit word, *laksha*, which means 100,000 units. It is a common belief that the word refers large number of insects it takes to make a unit of finished lac.

[3](Pt. Kasinath sastri 2017), Pt. Kasinath sastri, Dr. Gorakh Nath Chaturvedi. 2017. Caraka Samhita. Kshatkshin Chikatsa Chapter 11. Varanasi: Chaukhambha Bharati Academy.

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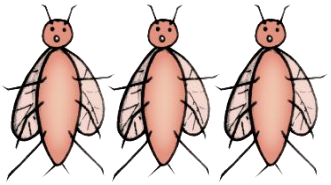

Figure 5: Insects dies to produce 1 Kg of lac(approx.)

Lac's Production

Lac is secreted by Laccifer Lacca beetle, to protect itself from other predators. The beetle latches onto the branches of selected host trees, thereafter sucking sap and secreting a resinous material known as lac.

This insect can be found in warmer climates, propagation and harvesting for economic gains, mainly in the forested areas of India, Thailand, and China. On an average, India produces about 21,000 metric tonnes of lac annually, and contributes around 55% of the total world demand. Over 90% of India's lac produce comes from the states of Chhattisgarh, Jharkhand, Madhya Pradesh and West Bengal.[4]

Thus, by encouraging the usage of lac can immensely benefit around one lakh farmers of these states by generating livelihood options for them.

Lac's Properties

Chemical Properties of Lac

[4](PRADAN n.d.), PRADAN, Professional Assistance For Development Action. n.d. "Lacquered Dreams, Promoting livelihoods through Lac." www.pradan.net. Accessed January 2019. http://www.pradan.net/.

Lac is mainly composed of 90% resin, which is further divided into two parts: 25% soft (ether-soluble) resin, and 75% hard (ether-insoluble) resin. According to John Mills and Stuart White, shellac is a terpenoid resin consisting of low molecular weight polymers (oligomers) formed by esterification of polyhydroxy carboxylic acids with one another.[5]

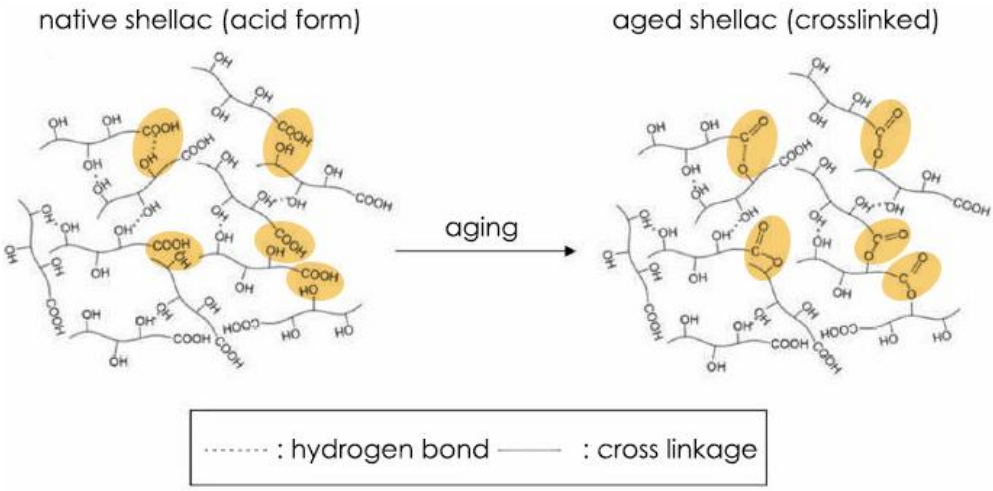

Figure 6: The schematic description of the process of esterification, which takes place during aging of shellac.6

Lac resin was a viscous, colourless liquid when first exuded by Laccifer Lacca, becoming harder and darker as esterification takes place. The polymerization of shellac takes place by esterification and the expelling of water (H2O), resulting in blocking and reduced solubility. Figure 4 shows the reaction of self-esterification that happens in shellac as it ages.[7]

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[5] ***(Derry 2012, 81), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo***

[6]***(Derry 2012, 85), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo***

[7]***(Derry 2012, 85), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo 8 (Derry 2012, 85), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis,***

As a result of esterification, shellac deteriorates with gradual loss of alcohol solubility, increase in melting point, and rise in alcohol insolubility, decreasing life and fluidity testing, as well as darkening in colour.[8]

Physical Composition of Refined Lac

Shellac's physical components

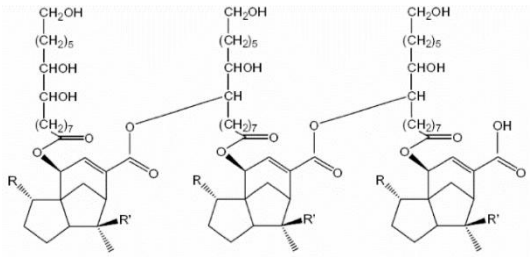
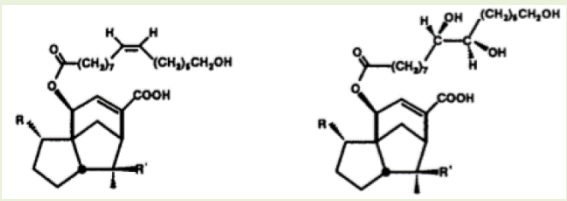
Resin (90.5%)	**Dyestuff (0.5%)**	**Volatiles (1.8%)**
Hard Resin (75%) 	**The composition of Lac seems to vary according to host tree, two acid groups have been identified in shellac; one being aleuritic and butolic acids, and the other being jalaric acid**	**Majorly H2O**
Soft Resin (25%) 		**Wax**

Table 1: Shellac's physical composition.9

Physical Properties Lac

Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo

[8](Derry 2012), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo

[9](Derry 2012), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of **Humanities, The Institute of Archeology, Conservation and History, University of Oslo**

- **Transparency: Depending on its wax content, lac has varying degrees of transparency. As the lac resin mixture is an amorphous polymer, a dewaxed variety will have higher transparency, since the wax particles naturally present in lac interfere with the passage of light.**
- **Gloss: The ability of a surface to reflect light and produce mirror like reflection is known as gloss finish. It is measured by the specular reflection of that surface. A matte surface displays the lower value of specular reflection, while a glossy surface has a higher value. Traditionally, lac has been used to achieve glossy finish but by applying methods like sanding and buffing, it can produce matte finish too.**
- **Colour: The natural colour of lac span from a rich amber yellow, to a dark reddish-brown. It is available in a wide range of colours and can be dyed to produce almost any colour. Mixing with pigments produce more opaque qualities, as the pigment blocks and scatters the visible light.**
- **Hardness: Lac buttons available in market are quite brittle in nature but as lac was traditionally used as a coating for floors and bowling alleys, it is certainly durable enough as a finishing material.[10]**
- **Barrier Properties: Lac coating displays excellent barrier characteristics against moisture, oxygen, temperature and humidity; hence, it is used as an organic coating for fruits and chocolates. The IINRG has developed a lac-based fruit coating formulation for Kinnow to increase its self-life.[11]**

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[10](Derry 2012), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo

[11](ICAR Review Committee n.d.), ICAR Review Committee, IINRG, Ranchi. n.d. "Technologies Available." Accessed January 2019. https://iinrg.icar.gov.in/.

- **Flexibility and Adhesion in Lac: According to William Gardner, the soft resin part of shellac acts as a natural plasticizer, whereas the hard resin is a brittle substance. Cockeram et al. reported that hard resin component is brittle but its adherence properties exceed those of shellac as a mixture. A blend of flexibility and adhesion means that a shellac film stick to the surface while it is sufficiently flexible to allow for some movement without failing as a coating.[12]**

  The superior adhesive abilities of shellac are suitable as a sealer/barrier coating when other coatings are to be used as topcoats, or to overcome surface problems, such as silicon contamination.

Industrial Applications of Lac

Surface Coating Industries	• **Heat and waterproof French polish (for glossy and attractive finish on wooden furniture, radio, TV cabinets, musical instruments, etc.)**
	• **Picture varnish (to protect pictures and paintings against dust, abrasions and humidity)**
	• **Book varnish**
	• **Emulsions and oil paints, synthetic enamels and ink**
Adhesive Industries	• **Gasket shellac compound (for repair and maintenance of automobile engines)**
	• **Sealing wax**

[12](Derry 2012), Derry, Juliane. 2012. Investigating Shellac: Documenting the process, Defining the product. Project-Based Masters Thesis, Oslo: Faculty of Humanities, The Institute of Archeology, Conservation and History, University of Oslo

	• **Lac glue (for glass, metal, plastic wood and cloth)**
	• **Particle board (as partition wall or false ceiling)**
	• **Making of bangles**
Electrical Industries	• **Insulating varnish (in electric motors, transformers and for manufacturing of other laminated products)**
Food & Medicines	• **As a fruits coating to increase the shelf life. The small amount of wax content in lac prevents moisture loss during fruit's storage.[13]**
	• **As a protective candy coatings or glazes on candies like Reese'sPieces, because of its ability to provide a high gloss in relatively thin coatings. It is approved by the FDA as a food safe coating.[14]**
	• **For coating enteric pills, so that they do not dissolve in the stomach, but in thelower intestine, which alleviates upset stomachs. It's also used as a coating on pills to "time release"medication.[15]**
Miscellaneous Applications	• **By-products such as lac dye and lac wax**

[13](OMRI 2014), OMRI, Organic Materials Review Institute (NGO). 2014. "Orange Shellac: Handling/Processing." Technical Evaluation Report compiled by OMRI for the USDA National Organic Program.

[14](OMRI 2014), OMRI, Organic Materials Review Institute (NGO). 2014. "Orange Shellac: Handling/Processing." Technical Evaluation Report compiled by OMRI for the USDA National Organic Program.

[15](Daniele Giovannone 2015), Daniele Giovannone, and Carlo De Angelis. 2015. Composition comprising shellac and/or a salt there of and sodium starch glycolate. Europe Patent EP 2 598 122 B1. 16 Sep.

	• **Jewellery and ornaments from valuable-coloured stones**
	• **For polishing and sharpening stones**

Table 2: Applications of Lac.16

Testing Manufacturing Processes

Through literature research, the physical and chemical properties of lac were explored. To understand lac as a material and check its suitability for modelling, it was necessary to try-out some tests on lac.

Casting with Lac

Test-01

Lac buttons were heated inside a stainless-steel bowl through gas stove. It was observed that lac got melted and then, started burning because of direct heating and got stick to the container. Dense lac globules were produced which have lower density than water.

Figure 7: Burned lac and lac globules.

[16](PRADAN n.d.), PRADAN, Professional Assistance For Development Action. n.d. "Lacquered Dreams, Promoting livelihoods through Lac." www.pradan.net. Accessed January 2019. http://www.pradan.net/.

Test-02

Lac buttons were heated inside an earthenware using an electric heater. Lac got melted and then, started burning because of direct heating. The temperature was then decreased so no lac globules were formed. As the melted lac is spread all over the utensil, upon cooling the utensil gets coated with lac. The moment lac starts cooling down its fluidity decreases. The layer of lac sticks with the earthenware also.

Figure 8: Melted lac in earthenware.

Test-03

This test involves heating of lac buttons indirectly inside a stainless-steel utensil. A mould of POP was created and Vaseline and coconut oil was applied on the surface.

Figure 9: POP mould on left being prepared for casting.

The mould was divided into 4 parts: surface coated with coconut oil, water applied over POP surface, surface coated with Vaseline and POP surface left as it is. Lac was heated in a container filled with water so as to avoid burning. Molten lac is denser than water, hence, it settles down and then the excess water is removed. Molten lac was poured over POP mould and left for cooling. After cooling, the POP mould is scrapped out to get lac.

Figure 10: Casting with lac using POP mould.

While removing POP, the surface applied with coconut oil and Vaseline releases easily but oil acts as a better releasing agent. Due to the presence of a significant amount of water in molten lac, bubbles appeared on the final form. The translucency of casted lac still remains intact.

Figure 11: Casted lac form

Test-04

Figure 12: Mixing equal amount of lac and Berja gum by weight (top left), preparing silicon mould for casting (top right), Pouring molten lac in silicon mould (bottom left), taking out the artefact out of mould (bottom right)

This test was done to check whether molten lac sticks to silicon's surface or not and if it is possible to produce similar artefacts using the same mould. Equal proportion of lac and Berja gum were melted together in water. Excess water was removed by boiling again.

Figure 13: Lac artefact produced.

Silicon mould was prepared for casting. Molten lac was poured in it and cooled for 10-15 mins to obtain the artefact. First successful solid lac product manufactured by casting. Because of equal proportion of gum and lac, setting time of final product increased. Lac didn't stick to silicon's surface. Rough finish of artefact can be attribute to presence of water. Same silicon mould can be used to produce similar artefacts. Silicon mould was able to withstand the heat of molten lac.

Press Moulding with Lac

Test-05

This test involves melting lac with water. Excess water from lac was removed and then it was boiled again to remove the

remaining water. After this, colour was mixed with molten lac to prepare a wet glass surface.

Figure 14: Pouring and spreading molten lac.

It was observed that water bubbles didn't appear on lac sheet and a uniform finished surface was produced after mixing colour. It was opaque. Lac didn't stick to glass because of water. The sheet got easily broke when dropped from a height of 1.2 meters.

Test-06

This was performed to check the strength of lac sheet. A mixture having 60% lac (powdered form), 30% wood flour and 10% Berja gum powder was prepared and placed on a plate. The container with the plate was filled with water and the boiling water melted lac without burning it. The plate was coated using Vaseline as a releasing agent. Cotton cloth was used to press the mixture constantly for an hour and let the mixture cool afterwards.

Figure 15: Preparing the mixture of lac, gum and wood flour.

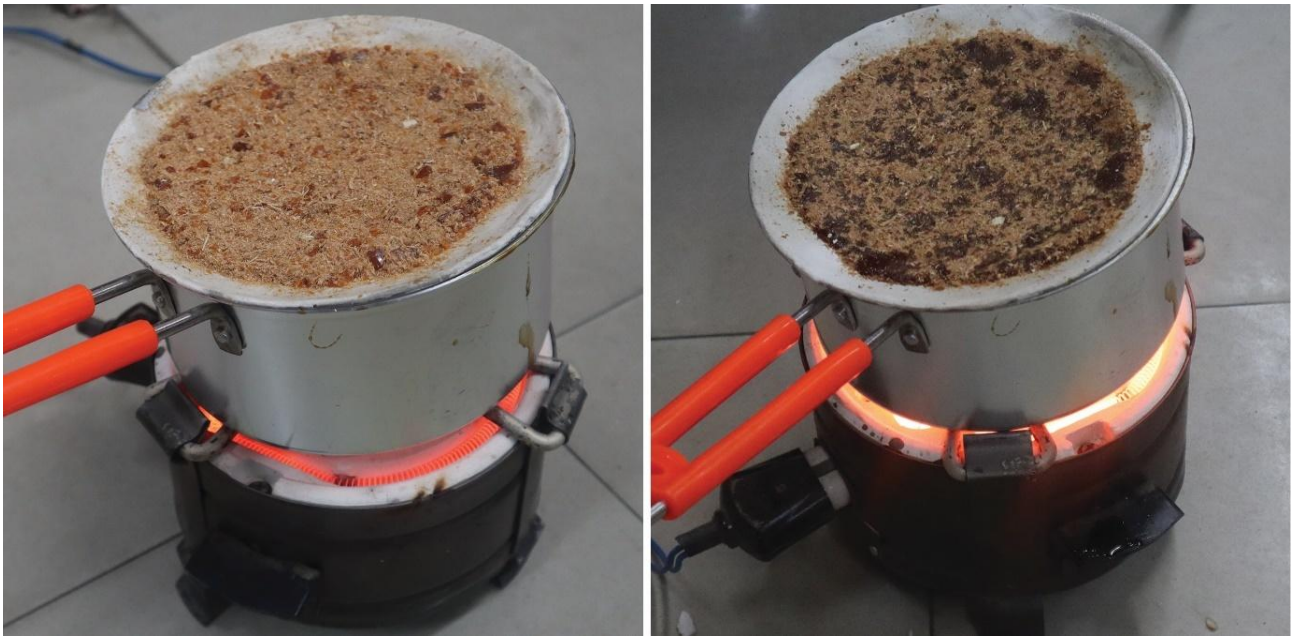

Figure 16: Change in colour of mixture.

Figure 17: Sheet of lac and wood mixture.

As the lac starts melting the colour of the mixture starts changing from light brown to dark brown. Lac acts as a binding agent to bind the wood flour particles together. Berja gums increase the adhesion of lac. The sheet of lac and wood mixture is quite sturdy and it didn't break when dropped from a height of 1.2 meters for 7-8 times.

Coating with Lac

Test-07

This test was done to liquify lac for polishing over various materials. A solution was prepared consisting of 75 gm of lac in 600 ml thinner. The solution was stirred in regular intervals for 1-2 days. Liquid lac was applied on paper using paint brush and the cotton cloth was directly dipped into solution and dried.

Figure 18: Change in lac and thinner solution after two days.

It was observed that lac dissolves completely in thinner and creates a sticky and viscous liquid. When applied on paper the thin layer of lac act as a barrier against water. Similarly, in case of

cotton cloth after applying a single coat of liquid lac its resistance towards water increased.

After drying, the cloth soaked with liquid lac became stiff and retained the form it acquired while hanging. When subjected towards heat the piece of cotton cloth losses its form and becomes flexible but as soon as it cools down it acquires the form given to it. Because of thinner, cloth fibres lose its strength and cloth can be easily torn off like paper but it is still stronger in comparison to paper.

Figure 19: Cotton cloth soaked in liquid lac solution displaying properties like waterproofing.

Test-08

This test was performed to check lac's adhesive properties, increase Paper Mache bowl's life and to use paper as a reinforcing element and check strength of the product.

First, paper pulp is prepared by soaking it in water for a day. Excess water is removed and wheat flour is added by 1/3rd of paper pulp's weight. Liquefied lac is also added as a binding agent. The paste is applied around a bowl and dried in sunlight for 2-3 days. It is then coated with lac buttons by spreading it through hot air gun. The hot air gun's temperature should be maintained between 150 -250°C.

The final outcome displays properties such as lightweight, sturdy, waterproof and smooth surface. The bowl turned out to be quite strong and it didn't break when thrown 2-3 times from a height of 1.2 meters. Lac coating proved to be efficient against water and the bowl was used several times to carry water similar to a regular plastic bowl.

Figure 20: Paper pulp, Dried Paper Mache bowl, Final Paper Mache bowl coated with lac (left to right.)

Additive Manufacturing with Lac

Test-09

This was done to check lac's usability with glue gun. A silicon mould is created for making lac sticks and molten lac is poured in it and dried for half an hour. Lac sticks were then used with glue gun. It was found that lac did come out of glue gun successfully. Although, due to uncontrolled heat provided by glue gun, the molten lac was spreading instead of attaining any height. After sometime because of friction the push mechanism of glue gun stopped working and sticks needed to be pushed manually.

Figure 21: Silicon mould used to make lac stick, using lac stick with glue gun (Left to right).

Outcomes

All the physical characteristics of lac mentioned earlier were confirmed by performing various tests. Still, the durability and performance of these products need to be checked for a longer duration in different climatic conditions. Other than those properties mentioned earlier, few more things noted about lac are as follows –

- **Natural plasticizer: The use of lac as a sealing and barrier agent against environmental conditions such as moisture, air and heat (up to some extent).**
- **Low softening and melting point: Lac soften around 60-70°C and starts melting around 70-80°C when it is in direct contact with heating source. While using hot air gun, more than 150°C is required for melting.**
- **Viscosity: Molten lac is quite viscous in nature and as it starts cooling down when its viscosity increases. Hence, to maintain its fluidity it has to be in constant contact with the heat source.**
- **Flexibility in lac: During the test conducted on lac, water was used to avoid burning lac. Hence, after cooling down it absorbed some amount of water and became more flexible as compared to button lac used earlier.**
- **Thermoplastic: While casting lac, it displayed its ability to become flexible on heating and hardening on cooling, and its ability to repeat the process again.**
- **Recyclable: The thermoplastic characteristic properties and lower melting point of lac makes it easily recyclable when used without any mixture.**
- **Low embodied energy: Because of low melting point, the energy required in modelling lac is quite low as compared to**

other conventional plastics used in model making. Hence, resulting in lower carbon emissions in the environment.

Lac as a modelling material

Technique applied	Time, Cost & Labour	End-of-Life
Hand modelling & sculpting	More time but easier to make	• Models once made can be reused again by crushing it into powdered form. • As lac is a food grade natural plastic, it can be consumed as a food or medicine in smaller quantities. • Low embodied energy makes it eco-friendly material.
Wire/thread cutting	Not possible	
Casting	Involves extra time, cost & labour for development of moulds. Once done models can be cooled down to reduce the setting time. Good for multiple repetitive models.	
Laser Cutting	Not possible	
FDM 3D printing	Needs a modified tool to do 3D printing. Not possible with current set of equipment.	
Pasting or Assembly	Done manually	
Colour & finish	Any colour can be mixed to produced desired result and it produces a glossy finish but the matte finish can also be achieved by sanding & buffing.	

Conclusion

The tests showed that the prevalent modelling techniques of casting, hand moulding, sanding and sculpting are possible with lac with a given set of equipment.

Figure 22: Hand sculpted cat model (Top Left), Hand moulded lac birds (Middle), Lac coated bowl (Top right), Lac coated tiles, Lac casted kulhaad (Bottom).

Whereas a modified tool is required to do additive manufacturing with lac. Similar to plasticine, lac models can be reused again to make newer models. Although, the brittle characteristic of smaller lac pieces makes it unsuitable to do detailed or zoom-in modelling but, it can be used in block or form development models. Therefore, lac has the ability to replace conventional materials in block modelling or models produced via casting. Also, the reusability of its models makes the whole process of modelling more sustainable. Thus, encouraging the usage of lac will not only help designers but will also be beneficial to various stakeholders involved in harvesting and processing of lac.

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Designing green buildings for all: understanding cost barriers to ensure effective implementation

Theme: Examining cost of green buildings to ensure effective implementation

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Abstract

Resource efficient buildings are key to mitigating the impacts of climate change. While the science of green buildings is well established, policy and market mechanisms exist, and awareness amongst masses is increasing, there is still a need to ensure effective on ground implementation and compliance with relevant codes, standards, and policies. The perception about green buildings being more expensive is one of the main barriers in widespread adoption of the concept.

The challenge is eminent especially in residential buildings where the incremental costs (if any) are borne by the private developers while the recurring benefits of lower operating costs are accrued by the occupants. This split incentive (where the economic benefit of going green is not accrued by the developer but passed on to occupants who have not paid additional money due to market competitiveness) has been addressed by 17 States and Union Territories across India, where various mechanisms including

revision of building byelaws, mandatory compliance, financial incentives, and ground coverage and FAR benefits have been announced for the private sector. Subsequently, the States of Haryana, Uttar Pradesh and Maharashtra have been leading in green building construction, and availing incentives announced by the respective government departments.

Using a case study of residential development from Greater Noida, this paper identifies the incremental cost of executing a green residential project and the role of incentives in offsetting any additional cost.

Keywords: ***Green buildings, cost, lifecycle cost of buildings, green building policies***

Introduction

India's Intended National Determined Contribution (INDC) under the Paris Agreement (2015) include key commitments towards (i) reduction in the emissions intensity of GDP by 33 to 35 per cent by 2030 from 2005 level, (ii) 40% of power capacity to be based on non-fossil fuels and (iii) creating an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through added forest and tree cover by 2030. [17]

The India Second Biennial Update Report to the United Nations Framework Convention on Climate Change, states that (i) the emission intensity of India's Gross Domestic Product (GDP) has reduced by 21% over the period of 2005 – 2014, (ii) by March 2018, 35% of power capacity is based on no-fossil fuels, and (iii)

[17] India NDC. INDCs as communicated by Parties. United Nations Framework Convention on Climate Change. [Online] 1 October 2015. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf.

emissions avoided by forest cover fall by more than half between 2010-14, where tree cover doubles in the same period.[18]

The progress by India has also been acknowledged by the United National Environment Program (UNEP) in its Emission Gap Report 2016, where India has been recognized for being on course for achieving its voluntary goals, without purchasing offsets.

Resource efficient buildings are key to mitigating the impacts of climate change.

While India's INDC are not binding to sector specific mitigation obligation or action, the goal is to reduce overall emission intensity, improve energy efficiency of the economy over time, and protect vulnerable sectors of economy and segments of society. Key priority areas identified for achieving India's INDCs include, "promoting energy efficiency in the economy, notably in industry, transportation,

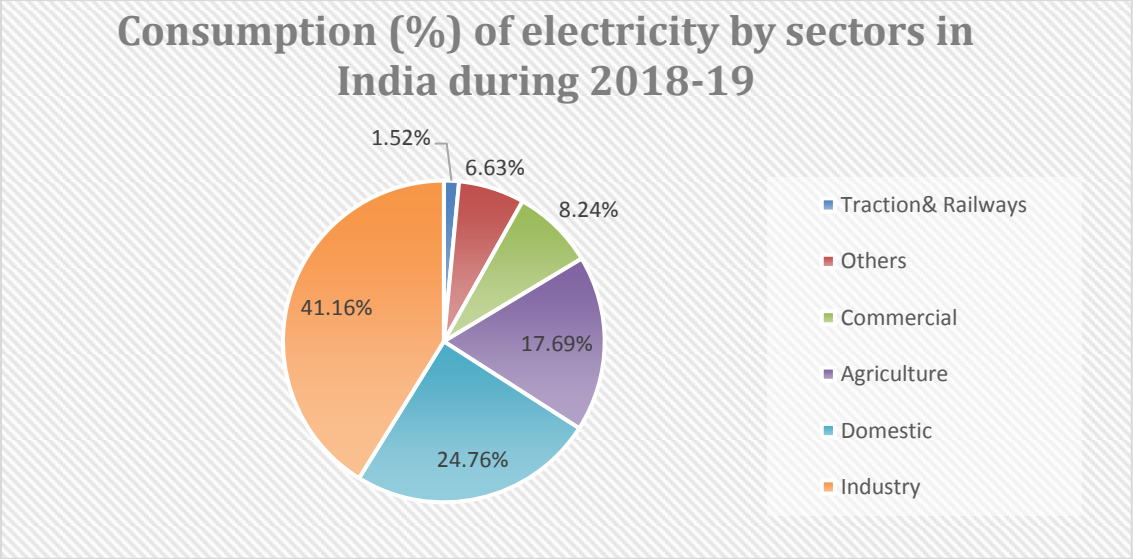

Figure 1: Total consumption of electricity by sectors in 2018-19

[18]Ministry of Environment, Forest and Climate Change, Government of India. Second Biennial Update Report to the United Nations Framework Convention on Climate Change. United Nations Framework Convention on Climate Change. [Online] December 2018. MoEFCC. (2018). India: Second Biennial Update Report to the United Nations Framework.

buildings and appliances". [19]

Considering the above achievements and given the fact that domestic and commercial sectors consume about 33% of electricity[20], [21] in India (Figure 1[22]), it can be concluded that the building sector has played a key role in progress towards achieving the INDCs. This has been accomplished through a definite plan of action for clean energy and energy efficiency in various sectors, with key focus on implementation of policies through green building rating systems and other mechanisms.

As per Graham and Rawal [23] and TERI [24], the role of the building sector (residential and commercial) in meeting India INDC targets for 2030 will be further significant. Electricity demand in residential and commercial buildings sectors is predicted to rise by 5 folds and 3 folds respectively by 2032[25]. Furthermore, energy efficiency in the building sector is likely to be the largest contributor (after industry) in further reduction of emissions intensity of Indian GDP by 2031.

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[19] See reference 1.

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[25] See reference 5

Policy mechanisms and incentives for green buildings exist.

Various ministries including the Ministry of Power (including Energy Efficiency Services Limited (EESL) and Bureau of Energy Efficiency (BEE)), the Ministry of New and Renewable Energy, the Ministry of Housing and Urban Poverty Alleviation (including the Central Public Works Department (CPWD), Bureau of Indian Standards (BIS)), and the Ministry of Environment, Forests and Climate Change have played a crucial role in designing policies and incentives for projects to incorporate resource efficiency through green building rating systems, in turn meeting India's INDCs (Figure 1).

Figure 1: Green building policy framework instituted by the Government of India; Source: Priyanka Kochhar

Table 1: GRIHA linked incentives at State and Municipal levels to achieve national goals and international commitments; Compiled by Priyanka Kochhar from information available at (26) and other State/ Municipal body websites

S.No	State	Year	Type of incentive	Municipal Body	Description
1	Andhra Pradesh	2017	Financial incentives	Municipal Administration and Urban Development Department	Urban local bodies shall provide following incentives to projects that follow "Andhra Pradesh Energy Conservation Building Code (APECBC) and are GRIHA/IGBC/ LEED India rated buildings: (a)20% Reduction on permit fees. (b)Payment of impact fee and development charges to be paid in four equal instalments before the completion period of the construction as given in the building permit order. (c)If the property is sold within three years, one-time reduction of 20% on duty on transfer of property.
		2015	Financial incentives	Industries and Commerce Department	Industrial Development Policy 2015-2020 promotes adoption of sustainable green measures across industries. The State Government will provide 25% subsidy of total fixed capital investment of the project (excluding cost of land, land

(26)GRIHA India. GRIHA Incentives. GRIHA India. [Online] https://www.grihaindia.org/griha-incentive.

					development, preliminary and pre-operative expenses and consultancy fees) for the industries that obtain GRIHA rating with a ceiling of INR 50 crore. 25% subsidy on total fixed capital investment of the project (excluding cost of land, land development, preliminary and preoperative expenses and consultancy fees) for buildings which obtain green rating from GRIHA/LEED/IGBC. This incentive is applicable for MSME and large industries.
2	**Delhi**	**2013**	**Ground coverage and FAR incentive**	**Delhi**	**Delhi Development Authority to provide free of cost 1% to 5% extra ground coverage and FAR for GRIHA projects of more than 3000 sqm plot size. In case of non compliance of above after obtaining occupancy certificate, penalty at market rate to be levied for incentive FAR by land owning agency.**
3	**Chandigarh**	**2015**	**Mandatory compliance**	**Chandigarh Administration**	**Chandigarh Administration has adopted CWPD guidelines for placing minimum three star GRIHA rating in all public building in future**
4	**Goa**	**2019**	**Mandatory compliance**	**Department of Town &**	**TCP Board in its 163rd meeting held**

				Country Planning	**on Monday evening approved Green Building concept, which will come into force from January 1, 2019. Government has decided to tie up with Indian Green Building Council (IGBC) and The Energy and Resources Institute (TERI) to set up guidelines. Government buildings, commercial projects and hotels with built up area of more than 2000 sq metres will compulsory have to go green.**
5	**Gujarat**	**2017**	**Additional FAR/ FSI incentive**	**Urban Development and Urban Housing Department**	**The Gujarat Comprehensive Development Control Regulations-2017 shall apply to the land development and building construction in the entire state. The Competent Authority shall offer some incentives in the rate of chargeable FSI for rating certified green buildings as 5% discount in the total payable amount (the owner shall have to apply for GRIHA rating certification prior to commencement of the project).**
		2015	**Financial incentives**	**Industry and Mines Department**	**Scheme for assistance to encouraging green practice and environmental audit**

					to MSME. Industrial buildings of more than 2000 sqm built up area with green rating under GRIHA/IGBC/LEED can get up to 50% of consulting charges or 2.5 lacs, whichever is less.
		2015	**Additional FAR/ FSI incentive**	**Ahmedabad Urban Development Authority**	**Comprehensive Development Plan 2021 lists out the various regulations for procedure, planning and performance to regulate buildings. The Competent Authority shall offer some incentives in the rate of chargeable FSI for rating certified Green buildings as 5% discount in the total payable amount (the owner shall have to apply for GRIHA rating certification prior to commencement of the project).**
6	**Haryana**	**2019**	**Mandatory compliance**	**Haryana Renewable Energy Development Agency**	**The city has issued G.O as regards to construction of Green buildings in compliance with approved National Rating Systems like GRIHA particularly in Government/PSUs buildings.**
		2017	**Additional FAR/ FSI incentive**	**Department of Town and Country Planning**	**The Haryana Building code 2017 incentivizes GRIHA/IGBC/LEED rated projects. Buildings with 1star**

					to 5 star GRIHA shall be eligible for 3%, 6%, 9%, 12% and 15% additional FAR respectively, and buildings with Silver, Gold or Platinum by LEED/IGBC shall be eligible for 9%, 12% and 15% additional FAR. The applicant has to pay only Infrastructure Development Charges on additional FAR granted as incentive.
7	**Himachal Pradesh**	**2017**	**Additional FAR/ FSI incentive**	**Town and Country Planning Department**	**Additional 10% FAR for projects which are granted Gold / Platinum rating by IGBC and Four Star/ Five Star by GRIHA Council.**
8	**Jharkhand**	**2017**	**Additional FAR/ FSI incentive**	**Urban Development and Housing Department**	**Depending on the level of rating achieved, GRIHA/IGBC rated projects of all building uses (except plotted residential) shall be awarded additional FAR up to 7%.**
9	**Kerala**	**2011**	**Mandatory compliance**	**Public Works Department**	**GRIHA/ LEED mandatory for all government projects, and private projects (other than residential buildings with plinth area less than 500Sq.m) to go for GRIHA certification. Small residential buildings may get rated by SVA GRIHA or IGBC Green Homes.**
10	**Maharashtra**	**2018**	**Financial incentives**	**Urban Development**	**2.5% to 7.5% rebate in development**

				Department	**charges for developers with projects availing 3 Star, 4 Star, 5 Star GRIHA rating or Silver, Gold, Platinum LEED rating from GBCI. The consumers will be eligible for a property tax rebate between 5% to 10% for the same levels of green ratings.**
		2017	**Additional FAR/ FSI incentive**	**Urban Development Department**	**Pune Municipal Corporation (PMC) and Pune Metropolitan Region Development Authority (PMRDA), Government of Maharashtra provide additional FAR of 3%, 5% and 7% for Green Buildings rated as Silver, Gold and Platinum respectively by IGBC/GBCI, Three Star, Four Star, Five Star by GRIHA Council, 30-30-30/40-40-40/50-50-50 by EDGE respectively.**
		2016	**Mandatory compliance**	**Public Works Department**	**LEED/GRIHA or any other (i.e. including EDGE) to be followed for all new and existing (requiring major repairs) government buildings constructed by PWD Maharashtra.**
		2015	**Financial incentives**	**Pune Municipal Corporation**	**GRIHA/SVA GRIHA/IGBC rated project developers will get 5%,10%, 15% discount on the premium charges (payable to the**

					corporation) as per 3Star/ Silver, 4Star/ Gold, 5Star/ Platinum rating awarded by the GRIHA Council/IGBC.
		2011	**Financial incentives**	**Pimpri Chinchwad Municipal Corporation**	**Incentives launched under MNRE scheme on "energy efficient solar/green buildings". As per the scheme, depending on the level of GRIHA/ SVA GRIHA rating, the project developer to avail discount in Premium between 10% to 50%. Additionally, occupants to avail property tax (between 5% to 10%) benefit based on the final rating.**
11	**Odisha**	**2018**	**Incentive as per State policy**	**Bhuvneshwar Development Authority (BDA)**	**LEED/GRIHA/IGBC have been incentivized as per applicable State Government policy In pursuance of the National Sustainable Habitat Mission on Energy Efficiency in Building, the Authority shall encourage for adoption of Leadership in Energy and Environmental Design (LEED) / Green Rating for Integrated Habitat Assessment (GRIHA), Indian Green Building Council (IGBC) and Energy Conservation Building Code (ECBC) (for Odisha ECBC Code and Guidelines - 2011 refer Annexure-**

					VI) rating certification for new and existing buildings. The incentive for the same would be based on applicable State Government policy as applicable from time to time.
12	**Punjab**	**2018**	**Mandatory compliance**	**Department of Local Government**	**Integration of GRIHA/ LEED/ IGBC within "Punjab Municipal Building Bye-Laws 2018". Incentives applicable as per notification issued in 2016**
		2016	**Additional FAR/ FSI incentive**	**Department of Local Government**	**An additional 5% Floor Area Ratio (FAR) free of charge for projects which are rated Gold or above by IGBC/ Gold or Platinum by LEED/Four Star or above by GRIHA shall be eligible for 5% additional free of cost FAR incentive.**
		2016	**Mandatory compliance**	**Public Works Department**	**Wherever client department specifically requires, the building shall be planned and designed as a green building as per the standards of TERI-GRIHA Rating or Indian Green Building Council Rating system and the additional cost shall be included in the estimates.**
		2013	**Additional FAR/ FSI incentive**	**Department of Housing and Urban Development**	**An additional 5% free of charge FAR shall be permissible to buildings with relevant certificates from GRIHA. In case**

					the promoter fails to submit maintenance certificate after a period of every five years from the Competent Authority, the defaulter can be penalized at the rate of 200 percent of additional floor area ratio permitted.
13	**Rajasthan**	**2019**	**Additional FAR/ FSI incentive**	**Urban Development Department**	**Projects achieving Platinum equivalent will be eligible for 15% free of cost extra BAR (Building Area Ratio), Gold equivalent for 10% free of cost extra BAR, and Silver equivalent for 7.5% free of cost extra BAR. If green building norms are not met, and the above BAR is built, then a "betterment tax" will be applicable on the extra BAR. During approval, development tax will be deposited for the extra BAR, which will be reimbursed on submission of IGBC/ GRIHA/ LEED rating documents.**
		2015	**Additional FAR/ FSI incentive**	**Department of Urban Development & Housing, Department of Local Self Government**	**Criteria for selection of partner in development of affordable housing projects in joint development agreement gives additional weightage to developers who have completed/ ongoing projects with IGBC/ GRIHA.**

					Additional FAR of 5% shall be provided in case of green building construction as per the provision of prevailing building byelaws subject to obtaining certification from the authorised agencies such as IGBC, LEEDS etc.
		2014	**Additional FAR/ FSI incentive**	**Jaipur Development Authority**	**Buildings with plot area more than 5000 sqm will be eligible for an additional 5% FAR free of charge if they get 4 or 5 star rating from GRIHA**
14	**Sikkim**	**2015**	**Mandatory compliance**	**Building and Housing Department**	**All the Government and semi-Government structures in the State (Residential, Non-residential, Healthcare, Institutional, Industrial, Recreational etc) including those belonging to autonomous bodies like Boards, Corporation, Companies and Public Sector Undertaking (PSU) shall conform to minimum 3 Stars GRIHA rating for propagating sustainable development in the State**
15	**Uttar Pradesh**	**2016**	**Additional FAR/ FSI incentive**	**Greater Noida Industrial Development Authority**	**Additional 5% FAR free of charge for projects which are rated as Gold or above by IGBC/LEED.**
		2015	**Additional FAR/ FSI incentive**	**Uttar Pradesh Housing and Urban**	**Free of cost additional 5% FAR for projects complying**

				Planning Department	**with 4 or 5 Star GRIHA rating**
		2015	**Additional FAR/ FSI incentive**	**Housing and Urban Planning Department**	**Additional 5% FAR free of charge for projects which are rated as Gold or above by IGBC or LEED (new and existing buildings undergoing retrofitting). Applicable to buildings on site more than 5000 sq. m.**
		2011	**Additional FAR/ FSI incentive**	**NOIDA and Greater NOIDA local bodies, Uttar Pradesh**	**Noida and Greater Noida have incentivized GRIHA/LEED projects on plots of minimum 5000 sqm with free cost 5% additional FAR (on existing FAR - so if the exiting FAR is 2.5% then its 5% of the 2.5% and not 5% total) for those complying with 4 or 5 Star GRIHA Rating/ Gold or Platinum LEED Rating.**
16	**Uttarakhand**	**2017**	**Additional FAR/ FSI incentive**	**Mussoorie Dehradun Development Authority**	**Private buildings which comply to rating systems and which successfully secure ratings from GRIHA / LEED / IGBC / BEE shall be eligible to receive extra F.A.R free of cost in the range of 10%, 20% and 30% for Silver/ Gold/ Platinum LEED Rating or 3 Star/ 4 Star/ 5 Star GRIHA Rating.**
		2017	**Mandatory compliance**	**Mussoorie Dehradun Development**	**All Government / State Government / Semi-Government**

				Authority	**buildings including those belonging to autonomous bodies like boards, corporations, public sector undertakings shall confirm to minimum 4-star GRIHA rating OR GOLD IGBC LEED to propagate green building construction. The concerned Architect shall submit affidavit for the implementation of the above provision.**
17	**West Bengal**	**2018**	**Additional FAR/ FSI incentive**	**Department of Urban Development & Municipal Affairs**	**10% additional Floor Area Ratio F.A.R. for "Green Building" as per provision LEED 'Gold' or higher level of LEED certification. Completion certificate for building linked to final certificate from GBCI**
		2016	**Additional FAR/ FSI incentive**	**New Kolkata Development Authority**	**Additional 10% FAR for projects Precertified/ Provisionally Certified as Gold or above by IGBC/ Four Star or above by GRIHA.**
		2015	**Additional FAR/ FSI incentive**	**Department of Municipal Affairs**	**10% additional FAR for green buildings which have been granted 4 star rating or higher under GRIHA rating system or Precertified/ Provisionally Certified as Gold or above by IGBC.**

The green building rating systems have been instrumental in embedding and executing resource efficiency in the building sector through transforming mechanisms for financial transactions. The National Housing bank (NHB), SIDBI and IIFL Home Loans have promoted the concept of green residential buildings (i.e., rated through GRIHA, IGBC, LEED, EDGE) through various financial structures and technical support programmes for developers, primary lending institutions (PLIs) and home buyers. These initiatives are linked to green building rating systems to ensure effective implementation on ground [27],[28].Though these programmes, namely the 'Promotional Programme for Energy Efficient New Residential Housing in India'[29] financial incentive by SIDBI[30] [31] [32]

Market mechanisms for mainstreaming of green buildings also exist.

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[27]Soni, Alankrita.Role of Financial Institutions in promoting green buildings. [interv.] Priyanka Kochhar. 20 March 2020.
[28]Kool, Amor.IIFL Kutumb initiative. [interv.] Priyanka Kochhar. 19 August 2020.
[29]National Housing Bank. Report on Trend and Progress of Housing in India 2014. National Housing Bank website. [Online] 2014. https://www.nhb.org.in/Publications/T&P_English_FINAL.pdf.

[30] A Review on Green Building Movement in India. Manna, Dibas and Banerjee, Sulagno. 2019, International Journal of Scientific and Technology Research, pp. 1980-1986.

[31]A Review on Green Building Movement in India. Manna, Dibas and Banerjee, Sulagno. 2019, International Journal of Scientific and Technology Research, pp. 1980-1986.[31]Economic Policy Forum. Promoting sustainable and inclusive growth in emerging economies: Green Buildings. Economic Policy Forum. [Online] 2016. https://economic-policy-forum.org/wp-content/uploads/2016/02/Sustainable-and-Inclusive-Growth-Green-Buildings.pdf.

[32] Yes Bank TERI BCSD. YES BANK – TERI BCSD Survey of Green Real Estate Sector 2014. Yes Bank. [Online] 2014. https://www.yesbank.in/pdf/researchandinitiatives_awardsandrecognition_pdf3.

financial incentives by SIDBI incentives by National Housing Bank and Agency Françoise de development (AFD) through SUNREF India [33], and launch of 'Kutumb' platform for green affordable housing by IIFL Home Loans [34], the financial institutions (FIs) have embedded implementation of energy efficiency measures with various finance transaction mechanisms for specific stakeholder groups. The work done by the FIs over the past two decades further lays the foundation for green climate fund instruments and green bonds to benefit the PLIs and end users in future where not just individual components such as solar water heaters and efficient equipment/ products get financed but real estate as a sector would benefit by incorporating green building features in their design. It is also required that the impact of schemes proposed and implemented in the past two decades is evaluated and studied for addressing any gaps and making future initiatives more effective.

Awareness and knowledge amongst stakeholders are

The green building certification agencies have played a crucial role in equipping professionals with knowledge and skills required for design, construction, and operation of certified green buildings [35], [36], [37]. By conducting nation-wide training programmes and

[33]Bank, Sunref India-National Housing. Sunref India affordable green housing : GRIHA incentive. GrihaIndia. [Online] https://www.grihaindia.org/sites/default/files/pdf/Griha-incentives/sunref-general.pdf.

[34]Loan, IIFL Home. Kutumb – Green Affordable Housing. IIFL Home Loan. [Online] 2019. https://www.iifl.com/kutumb/.

[35]See reference 18

[36]Ministry of New and Renewable Energy, Government of India. Ministry of New and Renewable Energy, Government of India. Annual Report. [Online] 31 March 2020. https://mnre.gov.in/img/documents/uploads/0ce0bba7b9f24b32aed4d89265d6b067.pdf.

workshops, and developing a cadre of professionals equipped with green building credentials (including GRIHA Certified Professionals, GRIHA Evaluators [38], LEED Green Associate, LEED AP with specialty, LEED Fellows [39], Indian Green Building Council Accredited Professional [40], EDGE Experts and Auditors [41], and GEM Certified Professional [42] the certification agencies provide for inclusion of qualified professionals as part of various project tender requirements. For example, the Request for Proposal for "Comprehensive Consultancy Services for North Zone Office Building Design" [43], requires that "The bidder should have at least one of the team members as GRIHA/ LEED Accredited Professional" [44]. Similarly, the Expression of Interest for "Empanelment of Consultants for Comprehensive Engineering Services" requires "The consultants shall have at least one LEED AP or IGBC AP or GRIHA Trainer or GRIHA Evaluator in their team." [45]

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[37]Lok Sabha Secretariat. LSS Committee Energy. Standing Committee on Energ (2017-18). [Online] March 2018. http://164.100.60.131/lsscommittee/Energy/16_Energy_32.pdf.

[38]GRIHA India. The GRIHA Community. GRIHA India. [Online] https://www.grihaindia.org/griha-community.

[39]U.S.Green Building Council. LEED professional credentials. U.S.Green Building Council. [Online] https://www.usgbc.org/credentials.

[40]Indian Green Building Council. IGBC Accredited Professional Examination. Indian Green Building Council. [Online] https://igbc.in/igbc/redirectHtml.htm?redVal=showIgbcApnosign.

[41]Green Business Certification Inc. EDGE Experts & Auditors. Excellence in Design for Greater Efficiencies. [Online] https://edge.gbci.org/auditors.

[42]The Associated Chambers of Commerce and Industry of India. GEM CP. Green Assocham. [Online] https://www.green-assocham.com/cms.php?id=19&menu_id=26&title=gem-cp.

[43]Bhubaneswar Municipal Corporation. Request for Proposal (RFP) for Comprehensive Consultancy Services for North Zone Office Building Design. Bhubaneswar Municipal Corporation. [Online] 8 December 2017. http://portal2.bmc.gov.in/Files/Keyprojects_22122017122721PM.pdf.

[44] See reference 31

[45]HITES. HLL Infra Tech Services Limited 'HITES'. HITES (A Fully Owned Subsidiary of HLL Lifecare Limited, a Government of India Undertaking). [Online] May 2017. http://hllhites.com/uploads/tenders/_882113102.pdf.

In the notification issued for 'integration of environmental condition in building bye-laws' [46], MoEFCC has notified empanelment of Qualified Building Environment Auditors (QBEAs) for the purpose of certification regarding incorporation of environmental conditions in buildings, where Indian Green Building Council has been identified as one of the agencies for the "process of accreditation, training, and renewal" [47] of QBEAs.

In addition to skill development amongst students through design competitions such as the GRIHA Trophy at NASA [48] the green building rating systems have been integrated into the formal curriculum of architectural schools across the country [49] to ensure students are equipped with theoretical and practical knowledge about green building concepts to make meaningful contribution as professionals.

Implementation of LEED Lab as part of the Bachelor's degree in Architecture (B.Arch) curriculum at a prominent Central University of India enables students to assess the performance of an existing building facility, with the goal of certifying the building with LEED for Building Operations and Maintenance (LEED O+M) process themselves.[50]

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[46]Ministry of Environment Forests and Climate Change. Notification on Integration of Environmental Conditions in Building and Construction Sector. Ministry of Environment Forests and Climate Change. [Online] 9 December 2016. http://moef.gov.in/wp-content/uploads/2017/07/Building-and-Construction.pdf.

[47] See reference 51

[48]National Association of Students of Architecture. Trophies. National Association of Students of Architecture. [Online] 2013. https://nasaindia.co/trophy/griha#collapse-two-link1_11_one1.

[49]Council of Architecture. Architectural Education. Council of Architecture. [Online] 11 August 2020. https://www.coa.gov.in/showfile.php?lang=1&level=1&sublinkid=748&lid=599.

[50]Jamia Millia Islamia. Press Releases. Jamia Millia Islamia A Central University. [Online] 6 August 2019. https://www.jmi.ac.in/upload/publication/pr2_English_2019August6pdf.pdf.

Considering the above, while the science of green buildings is well established, policy and market mechanisms exist, and awareness amongst masses is increasing, there is still a need to ensure effective on ground implementation and compliance with relevant codes, standards, and policies. The perception about green buildings being more expensive is one of the main barriers in widespread adoption of the concept.

Table 2 [51] below indicates percentage savings in resource consumption achieved by green rated buildings when compared to conventional buildings. Indicative increase in initial cost of green rated buildings, which may in part be set off by incentives (mentioned in Table 1) is also mentioned. This study by TERI may be analysed further because while the concept of assessing only initial increment cost has been used, benefits and cost savings are accrued over the life of the building.

Perception about green buildings being more expensive is one of the main barriers in widespread adoption of the concept.

Therefore, it is important to consider life cycle costs as opposed to initial incremental costs alone when making decisions about designing and constructing a green building.

Table 2: Resource savings and incremental costs incurred by rated green buildings

Certification Type	Commercial					Residential				
	Energy Savings (%)	Water savings (%)	Solid Waste reduction (%)	Waste Water reduction (%)	Cost Increment (%)	Energy Savings (%)	Water savings (%)	Solid Waste reduction (%)	Waste Water reduction (%)	Cost Increment (%)
Green Case	10	40-46	46	28-43	0.7-2.5	35	36-41	46	52-67	0.7-2.2
GRIHA 1 star	36	69-100	51	67-76	2.5-6.6	43	47-72	51	58-81	2.6-3.8
GRIHA 3 Star	54	69-100	55	72-86	6.5-11.9	57	57-83	55	66-88	4.8-5.2
GRIHA 5 Star	61	75-100	60	86-92	9.7-14.8	64	68-90	60	85-88	6.5-7.7
IGBC Silver	36	43-83	46	52-66	3.4-8.1	39	76-97	51	98-100	2.3-5.8
IGBC Gold	53	76-100	46	83-91	5.7-11.9	54	77-97	55	95-96	6.6-9.9
IGBC Platinum	56	76-100	51	83-91	9.1-15.1	59	77-94	60	95-97	6.7-7.7

[51]The Energy and Resource Institute. Formulation of Policy Incentives for Promoting Green Buildings in Tamil Nadu. TERI. [Online] 2016. https://www.teriin.org/sites/default/files/2018-03/2014BG08%20CMDA.pdf.

In addition to the financial savings [52], 10 million square metres of GRIHA 5-star certified project can save enough electricity to power about 1,00,000 urban homes, save enough water to meet needs of 22,000 urban homes, provide 6MW PV installation to enhance supply and provides monitored data to ensure and strengthen compliance, which are not considered when initial incremental costs are considered.

Residential buildings: cost, benefits, and incentives for green buildings

The challenge of considering only additional incremental cost (Table 2) as a decision-making metric is eminent especially in residential buildings where the initial incremental costs are borne by the private developers while the recurring benefits of lower operating costs are accrued by the occupants.

This split incentive (where the economic benefit of going green with possible extra expenditure is not accrued by the developer but passed on to occupants who have not paid additional money due to market competitiveness in spite of additional steps taken by the developer) has been addressed by 17 States and Union Territories across India (Table 1), where various mechanisms including revision of building byelaws, mandatory compliance, financial incentives, and ground coverage and FAR benefits have been announced for the private sector.

As per information collected by the author, the States of Haryana, Uttar Pradesh and Maharashtra have been leading in green building construction, and availing incentives announced by the respective government departments. NOIDA in Uttar Pradesh with

[52]GRIHA Council.Awareness programme: MCCIA-GEF initiative on GRIHA. Pune : GRIHA Council, 2013.

over 100 green buildings [(53)], Pimpri Chinchwad Municipal Corporation (PCMC) in Maharashtra with over 60 GRIHA projects [(54)] and the State of Haryana with over 30 green buildings [(55)] are ahead of other States in the process of receiving green rating linked additional FAR incentives as listed in Table 1.

Case study for residential sector

A project in NOIDA (where maximum number of projects are availing the green building incentive) has been identified for further study. The DAH group (i.e., private developer) PSI Energy, i.e., the green building consultants and project team of NX-One project have been interviewed to gain information on the role of incentives in offsetting any additional costs incurred by them in design and construction of GRIHA rated project.

Green building rating linked incentives by Greater NOIDA

In 2010, as part of the General Provisions for building projects, Greater NOIDA included additional free FAR for LEED certified projects constructed on plot size of more than 5000 sqm.[(56), (57)] Subsequent amendments in 2012, and 2019 went on to include incentives for projects certified by GRIHA and IGBC as well.

As per the incentive scheme, Greater NOIDA awards free cost 5% additional FAR (on existing FAR - so if the exiting FAR is 2.5% then its 5% of the 2.5% and not 5% total) for those complying

[(53)]Goyal, Mukesh.How many projects have availed the green building incentive in Noida. [interv.] Priyanka Kochhar. 1 September 2020.
[(54)]Karmarkar, Ketki.How many projects in PCMC have availed the GRIHA incentive. [interv.] Priyanka Kochhar. 1 September 2020.
[(55)]Singh, Hitender.How many projects have availed the green building rating linked incentive in Haryana. [interv.] Priyanka Kochhar. 1 September 2020.
[(56)]GRIHA Council. NOIDA and Greater NOIDA embrace GRIHA. GRIHA incentives. [Online] 20 October 2012. https://www.grihaindia.org/noida-and-greater-noida.
[(57)]Goyal, Mukesh.How many projects have availed the green building incentive in Noida. [interv.] Priyanka Kochhar. 1 September 2020.

with 4 or 5 Star GRIHA Rating/ Gold or Platinum LEED/IGBC Rating.

Case study 1: GRIHA 4 Star NX-One project, Greater NOIDA

The GRIHA pre- certified NX-One (Photograph 1) mixed-use project of approximately 3,38,402.6 sq m built up area [58] and cost of Rs. 800 crores [59] availed 5% additional free of cost FAR of 11,745 sq m. The cost of free of cost additional FAR [60] provided to the project (calculated as per the compounding fee letter of NOIDA [61], using rate of purchasing commercial/ residential FAR) is approximately Rs. 76.8 crores to the developer. The projected incremental cost (since the project is still under construction) incurred to meet requirements of GRIHA 4 Star (including SRI tiles, fly ash bricks, double glazing, roof insulation, BEE rated ceiling fans, solar PV power plant and automation for HVAC) are approximately Rs. 69.45 crores [62]. Thus, the additional cost incurred by the project (Rs. 69.64 crores) is absorbed by the value of free FAR incentive (Rs. 76.8

Photograph 1: GRIHA 4 Star pre certified NX-One, Greater Noida, Uttar Pradesh

[58]Sadarangani, K Shankar.NX-One, Noida. [interv.] Priyanka Kochhar. New Delhi, 12 September 2020.
[59]Uttar Pradesh Real Estate Regulatory Authority. View Projects. Uttar Pradesh Real Estate Regulatory Authority. [Online] 14 September 2020. https://www.up-rera.in/viewprojects.
[60]Goyal, Mukesh.How many projects have availed the green building incentive in Noida. [interv.] Priyanka Kochhar. 1 September 2020.
[61] As per discussion with NOIDA Authority officials (See reference 60), compounding fee for projects in Greater NOIDA is same as compounding fee for projects in NOIDA.
[62]Sadarangani, K Shankar.NX-One, Noida. [interv.] Priyanka Kochhar. New Delhi, 12 September 2020.

crores) for GRIHA rated NX-One project in Greater NOIDA. The local body has been able to effectively address the problem of incremental cost for green buildings and incentivise private players to adopt green buildings.

Discussion

It is understood that project developers incur additional initial cost while complying with strategies for resource efficiency and green rating. Several government agencies and local bodies offer incentives for private developers of residential developments so that the issue of spilt incentives can be addressed, and incremental costs can be offset.

Most recently, the Delhi Development Authority has released the Draft of Master Plan of Delhi (MPD) 2041, which mandates green buildings for any future construction in Delhi NCR. Such policy initiatives enable any additional green building linked expense to become the norm by making it the baseline.

Similarly, the Central Public Works Department (CPWD) and Public Works Department (PWD) in Maharashtra (among others) have announced integration of design strategies to achieve resource efficiency. Subsequently, the CPWD Works Manual, Plinth Area Rates and Delhi Schedule of Rates (i.e., documents used to estimate project costs and seek approval for construction) have been revised to include the Energy Conservation Building Code (ECBC) and Green Rating for Integrated Habitat Assessment (GRIHA Rating).

Even though these institutional projects incur an initial incremental cost, the benefits are more significant than initial incremental costs. Additionally, the occupant is also the owner

and hence reaps the environmental and cost saving benefits of initial investments.

However, to facilitate decision making, life cycle cost analysis is required to understand the significance of each cost component and the impact on total cost of the project. Evaluation of LCC considers single investment cost, capital replacement costs, energy consumption costs, annual recurring costs, and residual costs, which consolidates to form the total cost.

Conclusion

It is important for decision makers to consider life cycle costs (LCC) of projects so that various cost components are considered during decision making.

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Resilience Indicators for Barrier Free Planning and Design of Hospital Buildings in Multi-Disaster Scenario

Theme: Design for all as a key to disaster resilience of hospitals

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Abstract

Purpose: **The COVID-19 pandemic left the healthcare infrastructure upended given the patient surge. In India, hospital buildings were gravely impacted due to the compounding risks of the pandemic, floods and cyclones in 2021. This paper identifies the key resilience indicators featuring the barrier-free design and planning actions for the new construction of medium and large-scale hospital buildings with more than 100-bed capacity.**

Methods: **A modified Delphi technique is conducted in three rounds to identify the key indicators of resilience, wherein 57 indicators were identified in the first and second rounds of the survey. For the third round of the survey these indicators were grouped into three categories: a) master planning of hospitals campuses, b) Architectural design, c) building services and management. The corresponding indicators were ranked on a Likert scale of 1 to 9.**

Results: **The top 6 indicators are: 'barrier-free access to emergency services, 'linear configuration of buildings', 'location and modularity of building services', 'signages for internal circulation', 'circulation of high dependency patients, 'standardised structural grid for modularity of built-form.**

Conclusion: **Assessment of the top indicators highlight the importance of 'flexible and modular design' and 'barrier-free access' as key components of the resilient design of hospital buildings. These outcomes will help the construction professionals in making resilient hospital buildings to accommodate the patient surge.**

Key words: ***indicators, disaster resilience, barrier-free design, hospital planning, patient surge***

Introduction

Many climatic disasters through the decade and recently COVID 19 pandemic have posed grave challenges on healthcare infrastructure. Structural disruption, interrupting building services and discontinuity in medical supply chains are commonly observed during any calamity (Forbes, 2021). Inadequacy in healthcare services could directly lead to the uncontrolled spread of contagious diseases and other health risks (Govindan, K., et.al., 2020). Most recently, Gotri hospital, a Covid-19 facility in Vadodara, Gujarat collapsed due to strong winds generated out of cyclonic effects of Tauktae. After examination, it was found that the glass pane-façade was not designed to take the load of 60km/hr. Interior fitouts including the false ceiling and loose furniture fitting were also damaged. Given the inadequacy of the infrastructure, about 50 patients were shifted to other facilities. Despite, the early warning systems, 98 hospitals in Gujarat were

affected due to power outages and building service instability (IE,2021). The increment in the global frequency of hydrological disasters have resulted in severe loss and damages to healthcare facilities Over 168 hospitals in Kerala suffered loss and damages due to the 2018, floods. The cost of loss and damages was calculated up to a total of approximately Rs. 120 crores with the division being: hospital buildings (Rs 80 crore), medical equipment (Rs 10 crore), hospital furniture (Rs 10 crore), and medical supplies (Rs 20 crore) (Sphere India, 2018).

Thereafter many instances of disruption in healthcare infrastructure and services, the concept of resilient healthcare infrastructure gained its cognizance in 2020 through various policy and budgetary initiatives by the Government of India (GoI). In the Union Budget, 2020, GoI offered to increase public spending towards healthcare infrastructure from 1.6% to 2.5% of the GDP by 2025. This investment would reflect in reduction of out-of-pocket expenditure from 65% to 35%. Despite the policy interventions by the government, the need for assessing the hospital functionality was established with the COVID 19 outbreak along with the risks posed by natural disasters (Krishnan, S. and Patnaik, I., 2020). This paper intents to understand the nuances of 'resilience framework' in planning and design of hospital campuses with more than 100-bed capacity. As an outcome, a comprehensive literature review of various indicators of hospital resilience is presented. The corresponding indicators are then modified through three step delphi technique to systematically represent the opinion of the stakeholders.

Resilience of Hospital Buildings

Concept of resilience has been explored through various fields of ecology, environment, psychology, health, sociology and

engineering (Fleming, J. and Ledogar, R.J., 2008). The concept of resilience engineering focuses on unifying all the building's functions and its components (Holling, C. S., 1973). In the context of tertiary care hospital buildings, resilience is defined as '*the hospital's ability to resist, absorb, and respond to the shock of disasters while maintaining its critical health care functions, and then recover to its original state or adapt to a new one*' (Zhong, S. et.al.,2015). The components of resilience as derived through the definition are: a) resistance towards the extreme shocks, b) absorptive capacity of the system, c) response to aftermath of the disasters and d) adaptation of hospital functional capacity. These components of resilience have been looked from the perspective of management, with a focus on facility management and human resource management. Various hospital safety guidelines have revealed the structural and non-structural elements of the hospital buildings for risk mitigation. However, the role of design and planning of the hospital buildings in the resilience context have not been explored.

Hospital buildings represent one of the most complicated and critical emergency response resources (Shang, Q., et.al, 2020). A typical hospital facility depends on: a) access to hospitals, b) condition of the building services (mechanical, electrical and plumbing), and c) availability of healthcare workers (Fallah-Aliabadi, S., et.al., 2021). Malfunctioning of these elements will have a direct impact on the continuity of hospital functions and hence upended delivery of these services to the victims (Cristiano, S., et.al., 2021). Planning for unprecedented situations must estimate how patient surge can be capacitated within the hospital resources. These planning measures define the role for construction professionals, medical administration and disaster management administrators for manufacturing resilient hospital

buildings. In order to foster resilience in hospital facilities, identifying potential indicators for design and planning is prudent.

Methods

This paper has adopted Delphi method to identify potential indicators for ensuring resilience of hospital buildings (Freitas, Â.,et.al., 2018). The preliminary construct of these indicators is based on literature review of academic studies, standards, guidelines, norms and disaster assessment reports. These indicators are then modified through three stage Delphi method. This method allows the researchers to systematically weigh the opinion of the experts involved in planning, design and management of hospital buildings. The experts invited for this exercise were from the varied professions: medical officers, architects, planners, academicians, structural consultants and building service consultants. A total of 9 experts took part in the exercise after being versed with the aim and objectives of the survey. Transcript of records are processed by the author after the due written consent from the experts. In this paper, anonymity is maintained of the experts in accordance with the ethical approval by the institute. The methods for the identification of resilience indicators are explained in the following section.

Step-1

Table 1 indicates the preliminary construct of resilience attributes towards planning and design of hospital buildings with more than 100 bed capacity. These indicators are selected based on its frequency of occurrence in the corresponding literature.

Table 3 Preliminary construct of resilience indicators for hospital buildings

Code	Category	Preliminary Indicators	Source(s)
C1	Site assessment and planning	Accessibility to emergency and critical services	WHO, 2015; Jason Schroer., et. al., 2021
		Flexible grid planning for barrier free access	NDMA, 2016
		Site planning according to topographic profile	WHO, 2015
		Internal circulation and access ways	FEMA, 2008,2013,2020
		Adaptive planning of temporary camps to cater patient surge	PAHO, 2014; WHO,2015
C2	Architectural design	Elevated construction over stilts	FEMA, 2013
		Alternate entry and exits to critical services	FEMA2013; NDMA, 2016
		Installation of ramps for barrier free movement and access to medical spaces	WHO, 2015, 2019
		Flexibility for reorganizing space for expanding waiting areas	WHO, 2015; Anteby, R.,et.al., 2020
		Support infrastructure for healthcare workers and attendees to victims	WHO 2014, NDMA, 2016
		Signage for barrier free emergency movement and internal circulation	Shuayb, I., 2020
		Residential facility to accommodate additional hospital staff (on duty)	Toner, E.S., et.al.,2017
		Storage space and reserves of medical stockpiles and logistics	WHO 2015; Zhong, S., et.al., 2015
		Covered/Semi Covered spaces for refugee area setups	Krishnan,S.,et.al, 2020
C3	Building services and management	Modularity of HVAC systems for enhancing air exchanges	FEMA, 2013, 2020
		Uninterrupted supply of medical gas and electrical services in critical units	Cimellaro, G. P. 2021
		Decentralized (Independent) planning of	FEMA, 2020

Code	Category	Preliminary Indicators	Source(s)
		building services for the critical core	
		Location of medical services (Gas supply, lab equipment)	NDMA, 2016
		Planning for additional electrical load for expanded/special temporay facility	Krishnan,S.,et.al, 2020
		Robust Control, command and coordination systems for patient segregation and staff movement	Zhong, S., et.al., 2015; NDMA, 2016

The above set of indicators are also inclusive of 'evaluation framework' of hospitals including the hospital safety index, 2015. These indicators are divided into three categories as represented in table 1. These indicators are also in coherence with the components of resilience: resist, absorb, respond and adapt. Thus, unanimity of the resilience concept through design and planning of hospitals are maintained. For the purpose of evaluation of these potential indicators, the experts were invited through an online training program on 'Disaster Resilient Healthcare Infrastructure' jointly organized by the School of Planning and Architecture, Delhi and National Institute of Disaster Management, New Delhi in April 2021. The invited experts had more than 20 years of work experience in construction and management of large- scale hospital facilities. A content analysis of the transcript of records of the first round is represented in table 2.

According to the content analysis, maximum importance was given to 'Barrier free access to emergency services and modularity of structural grid of hospital buildings' and 'Direct correlation of adaptation planning with the extended bed capacity to accommodate the surge'. The respective concerns are identified after calculating the frequency of occurrence of the key

words/terms from the content analysis of the transcript of records from the first round of Delphi method.

Table 4 Content analysis of round 1 of Delphi Method

		Frequency of occurrence		
Concerns/Challenges	**Code**	**Overall**	**Medical**	**Non-Medical**
Site review according to ecology, environment, climate, geology and topography	**C1**	**1%**	**0%**	**2%**
Site assessment according to urban demographics to calculate the patient surge	**C1**	**5%**	**5%**	**5%**
Implementation of Building Code/Safety guidelines	**C2**	**6%**	**2%**	**8%**
Data assessment of disaster victims and loss of healthcare provisions is not accounted	**C3**	**8%**	**10%**	**6%**
Cost effectiveness of decentralization of building services	**C3**	**10%**	**15%**	**8%**
Plug and play of essential building and medical services for functioning of critical facilities in case of damage to hospital buildings	**C1**	**10%**	**13%**	**7%**
Over/Underutilization of hospital resources in case of patient surge	**C3**	**3%**	**5%**	**2%**
Lack of Healthcare Workers due to unavailability of personal and financial incentives	**C1**	**13%**	**15%**	**12%**
Direct correlation of adaptation planning with the extended bed capacity to accommodate the surge	**C2**	**13%**	**20%**	**9%**
Barrier Free access to emergency services and modularity of structural grid of hospital buildings	**C1**	**14%**	**12%**	**16%**
Site monitoring for building services in case of providing extended facilities	**C2**	**8%**	**4%**	**11%**
Flooding due to improper drainages at site level and due lack of maintenance of building services	**C2**	**10%**	**0%**	**16%**

1 Step-II and III

An online survey was designed to estimate the importance level of each indicator. This importance level was measured on a 9-point Likert scale.

1	2	3	4	5	6	7	8	9
Least Important				Moderately Important				Most Important

The construct of resilience indicators was revised according to the outcome of the first round of Delphi survey. After tabulating the descriptive statistics from the second round of the survey, third round of survey is modified. After formulating the final set of resilience indicators for the third-round, final ranking is done by the same set of experts.

Indicators of resilience

Master Planning of Hospital Campuses

In India, IS 12433-2 (2001) is a code of practice for basic planning requirements of 100 bed hospitals, prescribed by the Bureau of Indian Standards (BIS), GoI. The functional requirement of hospitals for site development is derived from IS 12377.1988. Several standards, norms and guidelines have been provided by national and international organization for the purpose of design, planning and development. Based on these standards and identified academic literature, broad domains for site assessment are: site selection, site review and assessment, urban controls and concept planning. The indicators identified for these domains are derived as per frequency of their occurrence of the key terms in the identified literature. Table 1 presents comprehensive list of derived indicators for the respective

domains. These indicators collectively correspond to the master planning of hospital campuses in view of fostering resilience.

Table 5 Resilience indicators for Master Planning of Hospital Campuses

Domain	Code	Indicator	Rank
Site selection	S1	Access to site	1
	S2	Location of Hospitals Site as per geological conditions	9
	S3	Urban demographic profile	5
	S4	Hazard and vulnerability profile	11
	S5	User identification and typology	13
	S6	Segregation of spaces as per type of medical services	15
Site review and Assessment	S7	Superimposition of micro-zonation maps	4
	S8	Review of micro and macro climatic conditions	14
	S9	Review of site ecosystem and local environment	18
	S10	Soil Assessment	12
	S11	Topographic assessment	16
Urban controls	S12	Compliance to government regulations	19
	S13	Formulation and compliance to bye-laws	17
	S14	Guidelines for buildable areas	20
	S15	Vertical and horizontal segregation of departments	6
Concept planning	S16	Accessibility to emergency services	3
	S17	Efficient planning of ambulatory services	21
	S18	Parking and quick access to emergency areas	10
	S19	Building typology and configuration	2
	S20	Planning in view of topographic profile	22
	S21	Planning of site services	8
	S22	Spatial allocation for refugees/victims/patient surge	7
	S23	Temporary built expansion for adaptation of medical services	23

Architectural Design

Resilient design studies have been explored from the perspective of structural integrity and resistance to external shocks. Considering hospital resilience as system's functional capacity to withstand external pressures of disasters, a coherence between built form, structure and medical functions are set. In this section, potential indicators covering the architectural aspects have been

identified. These indicators are categorized into 3 domains of architectural design: a) spatial planning and allocation of departments, b) built form and structure and c) Movement and circulation, as represented in table 4.

Table 6 Resilience Indicators for hospital architecture

Domain	Code	Indicator	Rank
Spatial planning and allocation of departments	D1	Modularity of structural grid for inter-departmental connections	7
	D2	Spatial arrangement of building clusters to accommodate surge in case of disaster	15
	D3	Accessibility of Helicopters/choppers	17
	D4	Planning of Support Infrastructure for attendants	8
Built-form and Structure	D5	Interior finishes of walls, floors, doors and windows	12
	D6	Typology and Configuration of building form	9
	D7	Elevated Plinth/ Stilt/Raised Construction	6
	D9	Alternate Entry and Exit at grade/Upper Levels	13
	D10	Planning flexibility (temporary facilities Flexibility of reorganizing Space in case of surge of patients)	3
	D11	Covered/Semi Covered spaces for Temporary set ups	14
	D12	Installation of ramps for circulation of victims	
	D13	Choice of material for ceiling and flooring of the hospitals to mitigate fire risk	11
	D14	Flexibility of Interior fit-outs	4
Movement and Circulation	D15	Horizontal and vertical movement of high dependency patients units (HDU/ICU/CCU)	10
	D16	Connectivity to hospital infra for managing such capacities	14

Domain	Code	Indicator	Rank
	D17	Protocol for signages and layout diagrams for HDU patient and staff movement in case of surge	5
	D18	Easy access and wayfinding to the utility core (staircases, ramps, lifts, toilets)	15
	D19	Barrier free access to emergency and critical services	2
	D20	Universal access to medical first aid	1

Building Services and Management

Hospital system functioning is highly dependent on uninterrupted functioning of mechanical, engineering and plumbing (MEP) services. Given the multiple inter-dependencies of these services this section identifies a set of indicators that are categorized into two major domains: a) design of building services and its operations and b) management and maintenance, as presented in table 5.

Table 7 Resilience indicators for design of building services and management

Domain	Code	Indicator	Rank
Design and Operations	B1	Type of HVAC service to the critical units, wards, OPD and IPD (Centralized/decentralized)	6
	B2	Location of source supply of Medical Services (medical Gas supply, lab equipment) to critical units on stilt floor to avoid flooding	2
	B3	Modularity of HVAC system for varied air exchanges in the isolation facilities	5
	B4	Provision of uninterrupted supply of	1

		electrical services for critical areas	
	B5	**Fresh water supply in case of flooding**	**9**
	B6	**Installation of HEPA and UV filters for better indoor air quality**	**8**
	B7	**Flexible design of services for future expansion in case of surge**	**6**
Management and Maintenance	**B8**	**Maintenance of oxygen levels in critical units**	**4**
	B9	**Water proofing of basements and avoiding drainage failure including pipe bursts**	**10**
	B10	**Seismic support to the services cables for electrical supply**	**13**
	B11	**Services design and maintenance minimizing patient self-harm opportunities**	**3**
	B12	**Grading of power supply as per clinical risk grade**	**7**
	B13	**Appropriation of pressure differentials of HVAC systems**	**14**
	B14	**Terminal equipment location**	**11**

Conclusion

This paper presents a comprehensive set of resilience indicators for planning, design and management of hospitals to combat the aftermath of disasters. These indicators are directly correlated to the components of resilience and can be used for the purpose of evaluation of hospital functions. The ranking of these indicators gives perceptive importance of these indicators for the management to take priority actions. The results of this paper highlight the importance of 'site accessibility' and 'access to emergency areas' for the purpose of adaptation planning of hospital buildings. Considering the architectural and building services attributes of design, highest importance is given to 'locational and modular planning of building services',

'configuration and typology of the built spaces' and 'barrier free access to the emergency areas'. Various codes of practices mandate the construction professionals to adhere to these indicators, however, these are often not given priority in planning and construction practices. A comprehensive list of planning and design considerations and emphasis given to the key indicators, thereby helps the professionals to incorporate resilient design practices for both retrofitting and new construction of hospital campuses.

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Indian standard 12433-2 for 'basic requirements for hospital planning

part 2 up to 100 bedded hospitals'

Indian standard 12377.1988, 'classification and matrix for

Various categories of hospitals'

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Dis-Ability and the Built Environment: A Literature Review

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Abstract: there have been worldwide efforts to move towards inclusive design via legislation, guidelines, and policy motivated by health, social, sustainable development goals. Paper links together strands of research in which inclusion of all is a primary concern especially in the context of the built environment with a broader interest to understand how inclusion of all in built environment is supported or contested by research. Paper reviews literature of the recent decade- 2010-2021 having words 'inclusion and built environment' in their title on Google Scholar. Literature is organized in three categories: 1.) Disability, Barrier and exclusion, 2.) Ability, access, and inclusion 3.) Indian context. Paper finds that most of the literature is focused on the minimum standard that does not provide inclusive solution and even ratification to UNCRPD has not yet resulted in inclusive design for all, even in developed countries.

Keywords: ***accessibility, inclusion, disability and diversity***

Introduction:

Built environment and human interactions have been studied by various researchers in sociology, ergonomics, and architecture and it is established that a built environment can facilitate or hinder one's ability to participate in day-to-day activities (Mulligan et al., 2018). Even though the population with

a disability is the world's largest minority but is often overlooked (Jonckheere, 2020). A study conducted to understand architect's (designer of-built environment) conception of the human body concludes that the human body or the user of the built environment has been reduced to a specific type and architecture theories and practices fail to acknowledge bodily diversity (Imrie, 2003). Designing for the able-bodied is a form of discrimination that affects their social life by imposing physical barriers for people with ethnic, gender, or physical differences. A good design acknowledges the diverse nature of people and does not impose physical, cultural, or social barriers. The barrier-free concept is an aftermath of the 70's disability rights movements that influenced the creation of the 1990 American with Disabilities Act (Lund, 2021). In addition, there have been growing scholarly literature on Inclusive environment, particularly need to go beyond bare minimum standards is highlighted.

Paper takes stock of the literature published between 2010-2021 and links together various strands of research in which "design for all (inclusion for all) is a primary concern. Our broader interest is to better understand how importance of design for all is supported by scholarship. Inclusion of all is explicit part of Agengda-2030 and even master plan of various cities (MPD-2041) and we want to access inclusion of all in context of built environment is supported by research.

A search on google scholar for journal articles with the words 'inclusion and built environment' in the title yields 23 results. Papers from 2010-2021 are included in the review. The paper is structured as follows: The first part of the literature highlights various barriers encountered by diverse user groups that disables them and leads to social exclusion. The second part of the

literature highlights the research that provides in-depth knowledge of the barrier-free concept and the third part highlights India's aspirations to become inclusive and action taken to achieve inclusion for all.

Though there have been worldwide efforts to move towards inclusive design of built-environment via legislation and guidelines, for example, American act with disability 1990, Right of Person with Disability Act 2016 (India), that protects against discrimination and comprehensive design standards like New-Zeeland Building code, a handbook on barrier-free and accessibility provide standards for accessibility (Mulligan et al., 2018). But most of the literature concerned with disability from architectural point of view is didactic and focused on standards and doesn't provide an in-depth understanding of the concept. While BS 8300-2:2018 Design of an accessible and inclusive built environment-Code of Practice and NZS 4121: Design for access and mobility advocates going beyond bare minimum standards and move towards universal design concept.

Disability, barriers, and exclusion: Built environment can facilitate or hinder one's ability to participate in day-to-day activities (Mulligan et al., 2018). There is an increase in interest towards human-centric architecture among research scholars' but in the practical, built environment is largely seen to have been constructed without reference to the physical needs of different types of users. Users of the built environment has been reduced to a specific type, fit and able bodied with symmetrical body proportions. Architecture theories and practices fail to acknowledge bodily diversity (Imrie, 2003). Design for inclusive is perceived as challenging by architectural students and practicing architects find it difficult to incorporate elements of inclusive

design as clients do not want to invest in this because it has additional cost associated and commercial space profit is reduced (Mulligan et al., 2018). However, Murugkar Kavita notes that accessibility measures, when planned at the design stage, would result in one percent to 1.2 percent of the construction cost. Most of the architects while designing, have no conception or have a self-referential image of the human body or as noted by McAnulty,1992 a statistically balanced symmetrical figure. The built environment lacks acknowledging bodily, cultural, gender, age diversity and continues to excluding their needs and wants. The literature review notes that various groups of the population face barriers in the built environment including elders, caregivers, pregnant women, people with impairment. Most of the literature concerned with disability from an architectural point of view is didactic and focused on standards and doesn't provide an in-depth understanding of the concept (Lund, 2021). Built environments that do not cater to the needs of all impose significant barriers and disables them from living a dignified life and performing to the best of their abilities. A study notes that only less than 5% of people with disabilities have access to services.

Ability, access, and inclusion: United nations convention on the right of persons with a disability considers that disability is a result of interaction between a person with impairment and environmental, attitudinal barriers that hinder their effective participation in society. It is the lack of opportunity to participate in social, cultural, economic life due to barriers imposed that hamper an individual's ability (Chęć-Małyszek, 2019). These barriers are a result of obstacles encountered due to various factors including communicational, cultural, economic, environmental, institutional, political, social, attitudinal, or structural factors. (RPWD,2016) The person with impairments is

perceived as other by able-bodied persons and encounter various barriers like social, physical, cultural that affect their life and mostly they are bound to stay home due to lack of independent mobility and access (Chęć-Małyszek, 2019). Though Person with disability have the full right as an individual but because of their impairments, are disadvantaged by environmental, economic, and social barriers (European Forum of the European Parliament) .

It is the dismantling of these barriers that can enable everyone in participating as active members of society (UNCRPD). In the context of the architecture and built environment, it is the inclusive design that is about creating environments that allow everyone the same opportunity of use, enjoyment, and experience without separation as noted by S. Neil and D. David. (Smith & Dropkin, 2012) A group of research scholars (Mulligan, Kerry & Calder, Allyson & Mulligan, Hilda 2017) notes that inclusive design can also be referred to as universal design, accessible design, and barrier-free design while another group (Smith, Neil & Dropkin, David 2012) notes that a design may be accessible but not inclusive. As highlighted in BS 8300-2:2018 Design of an accessible and inclusive built environment-Code of Practice and NZS 4121: Design for access and mobility Inclusive design goes beyond bare minimum standards. Inclusive design questions bolt-on solutions like provision of the separate ramp and separate stepped access as it separates the users into abled and disabled. It is important to note that one solution might be usable for all users. For example, designing for wheelchair access may exclude a person with impairment making it difficult for him to bent. An inclusive design might provide flexible solutions. For example, choice of surface material, adjustable height of the working surface (Smith & Dropkin, 2012). At some point in their lives (injury, pregnancy, old age), people may require the same

provision that is made for a disabled person and as recognized by Planning policy guidelines, UK inclusive design is about making places everyone can use. As highlighted by Ar. Kumta designing for a barrier-free environment is not a special requirement but a fundamental need (Kumtha Parul, 2020). UNCRPD highlights the importance of 'leaving no one behind as an approach to achieve sustainable development. Inclusive design should be seen as fundamental in process of designing the built environment (Mulligan et al., 2018) and it must be considered from inception to completion (Smith & Dropkin, 2012). RIBA plan of work assists in incorporating principles of inclusive design at various work stages.

Indian Context: India has around 3 crore persons 'disabled' which amounts to 2.21% of the total population (National Census 2011). India's population needing universal accessibility is estimated at around 25% (BASIIC). Persons with disabilities are the largest minority in India but are the least visible and are deprived of fundamental rights (Structural Framework for Accessible Infrastructure in Smart Cities, n.d.). India aspires to become inclusive for all as it has ratified UNCRPD and has obligations to identification and elimination of obstacles and barriers to accessibility that in applies to buildings including schools, housing, medical facilities and workplace and other indoor and outdoor facilities. To fulfills the obligations to the UNCRPDand *Rights of Persons with Disabilities Act, 2016* was formulated and it replaced Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995. also Access India Campaign was also launched in 2015 to meet the aspiration of inclusivity. Although accessible design in India has gained relevance, even official documents like Master plan Delhi, 2041, highlights the need for designing for all. There

are documents like Handbook on Barrier-Free and Accessibility, Central Public Works Department (CPWD), 2014, Harmonized Guidelines and Space Standards for Barrier-Free Built Environment for Persons with Disability and Elderly Persons, Ministry of Urban Development, 2015, National Building Code of India, Bureau of Indian Standard (BIS) in India detailing the standards for accessibility in India. A comparative study of these documents concludes that there has been no authentic study undertaken in India, concerning the accessibility needs of persons with different disabilities, keeping in mind the range of assistive devices/technologies being used, cultural aspects, terrains in rural/urban/hilly regions, and it needs to include a lot more technical detail to make it appropriate as a reference (DOEC, 2016). These building standards are not mandatory to comply with the built environment and are based on western models instead of research-based standards to serve Indian needs (Solanki & Khare, 2018). While India is witnessing rapid urbanization, the rural scene remains neglected in its basic amenities and other infrastructural support. Low economic status, lack of facilities present challenges for a person with disabilities in rural India, and the impact of impairments is much significant in a rural setting as compared to urban settings (Raheja).

Conclusion: Inclusive design has taken on a special significance in recent years from bare minimum standard implementation to advocating what disabled and neglected users want instead of perceiving what they need. Inclusive design is forming an essential basis for achieving social, economic health, and sustainable development objectives. Reviewing the literature of the recent 10 years related to inclusion and built environment, the paper summarizes the research in three parts. Review links together strands of reteaching, policy, legislation, guidelines from

global overview to Indian context along with providing an in-depth understanding of various terms including disability, barriers, social exclusion, and inclusive design. The rise of barrier-free architecture is a study that presents a view of how barrier-free architecture came into existence, the struggle, and the timeline of its development. From social stigma about the disabled person to consider them as individuals with full rights, social perspective in certain parts of the world has evolved but remain unchanged especially in small and medium towns, rural settings of India. A person with otherness (perceived as different in terms of physical appearance, gender, ethnicity, sexual orientation, sex) continue to encounter environmental and attitudinal barriers. While there is recognition that something as basic as access for all should factor in via Ratification to UNCRPD, Delhi master plan 2041, BASIIC, RPWD 2016.

The main conclusion of the review can be summarized as follows. Firstly, the need for advocacy for an environment inclusive of all has improved substantially over the past decade motivated by the development of country-level legislation, policy, guidelines but in reality, even in developed countries like New Zeeland, this has not yet resulted in design inclusive of all people. Secondly, when it comes to users of the built environment, it is barriers that disable them or hinder their ability to participate effectively. Certain documents and research provide in-depth knowledge of the idea of inclusive design like BSI- 8300, NZS 4121, Access and inclusion by Neil Smith and David Dropkin, RIBA- plan of work: inclusive design overlay that can assist in dismantling barrier and help in achieving built environments inclusive of all. Thirdly, when it comes to India, though India has obligations to UNCRPD, ongoing programmers like Sugamya Bharat, mention of inclusivity in Delhi master plan-2041, there is no mandatory obligation to make built-

environment inclusive. In small and medium towns and rural areas stigma, ignorance, lack of awareness continues to impose challenges to the user that are perceived as other by able-bodied users.

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Gender Inclusive Development for Public Spaces

Theme: Promoting Gender Inclusive spaces in Urban Development

Abstract

In the wake of economic liberalization, Indian cities have witnessed constant remodelling of spaces to keep pace with unprecedented urbanization. Alongside this wave of development, there is an undercurrent of increased vulnerability and isolation of marginalized sections of society that have been at a disadvantage because of their gender, class, age, and sexual orientation. The present situation is such that, the cities offer extensive possibilities, all while urban advancements have resulted in the increased exclusion of people, particularly from the marginalized sections. It has reinforced the existing structure of gender-based discrimination. Among the many layers of discrimination and exclusion, gender occupies a primary position.

Taking constructs from this consequence, this paper formulates an interesting proposition, one that is a common conception that people's behaviour and, accordingly, the use of spaces is changing – and that this leads to the emergence of Gender-sensitive urban development. It identifies the importance of creating spaces that evoke-affect-inspire people through physical and digital interventions. While gender-sensitive development for public spaces can induce psycho-socio, behavioral and cultural changes that can impede their use, appropriation, and safety for its users; local-to-local dialogues can be a powerful medium to enhance local governance and participation of grassroots by stimulating conversation with local stakeholders.

Aimed at integrating technology and urban development, the paper proposes a digital app based on an algorithm identifying the parameters contributing towards the direct impact and the perception of safety. The algorithm can feed into identifying the safest route for a person, based on the identified factors. The output will not only contribute significantly to citizen safety, but will also aid in the improvement and monitoring of infrastructural elements, as well as having a direct impact on making places safe and secure.

With a scheme implementable in phases over the years, this idea envisages equality for all leading to fair-shared, safe, and sustainable cities.

Keywords: ***Gender Inclusive Architecture, Women empowerment, Urban Development***

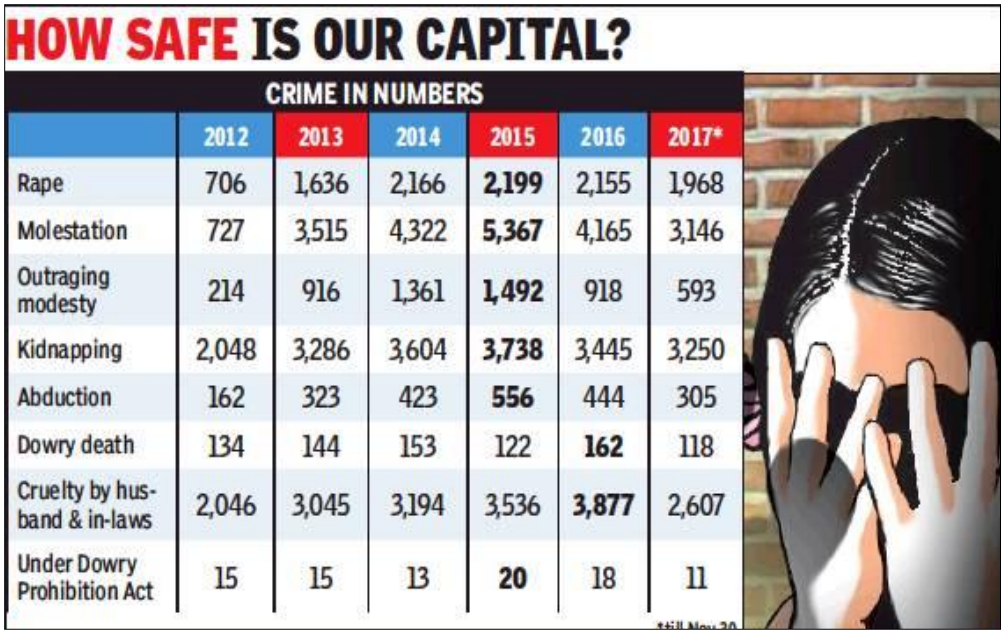
1. Introduction

Cities have been envisioned as spaces of liberation, collaboration, and ideas. The present situation is such that on one hand, the cities offer extensive possibilities for both women and men, while on the other hand, the nature of urban advancement has resulted in the increased exclusion of people, particularly from the marginalized sections; it has reinforced the existing structure of gender-based discrimination. This vulnerability is evident in the way these marginalized groups are denied or are unable to access what the city has to offer by compelling them to negotiate their movements across the city, thereby influencing their quality of life.

Among the many layers of discrimination and exclusion, gender occupies a primary position. Many factors play a major role in determining women's access to the city. Gender-based intolerance

and safety are now being dissolved within a framework that stretches beyond the immediate and the most discernible forms of violence, taking into its fold issues related to infrastructure, urban planning, and governance.

Today, the women in India representing a better half of the society are becoming the most vulnerable section in terms of their safety and security. As we go through the newspaper, we come across several headlines reporting cases of molestation, sexual harassment, rapes, trafficking, and violence against women in public spaces. According to the National Crime Records Bureau, 228,650 crimes against women including murder, rape, kidnapping, and sexual harassment were reported in 2011. India was



	2012	2013	2014	2015	2016	2017*
Rape	706	1,636	2,166	**2,199**	2,155	1,968
Molestation	727	3,515	4,322	**5,367**	4,165	3,146
Outraging modesty	214	916	1,361	**1,492**	918	593
Kidnapping	2,048	3,286	3,604	**3,738**	3,445	3,250
Abduction	162	323	423	**556**	444	305
Dowry death	134	144	153	122	**162**	118
Cruelty by husband & in-laws	2,046	3,045	3,194	3,536	**3,877**	2,607
Under Dowry Prohibition Act	15	15	13	**20**	18	11

*till Nov 30

Figure 1: Data representing the crime situation in Delhi, 2017. Source © The Hindustan Times

ranked as the world's fourth most dangerous country for women, behind only Afghanistan, the Democratic Republic of the Congo, and Pakistan by an international survey in the same year.

Women face violence both in public and private spheres that are often influenced by urban design choices and the organization of

public amenities. They experience a higher degree of insecurity that restricts their "access" and "use of the city". During times of conflict or social unrest, factors such as inadequate street lighting, unsafe public areas, ineffective community policing, and unreliable public transport can further exacerbate the risk of gender-based violence.

Government and police initiatives have not been too successful in addressing the concerns related to violence against women and safety in a concerted manner. The scope of technology such as panic buttons and GPS tracking to enhance public safety in certain ways is limited. While these initiatives are to be lauded, the principal drawback is that they exclude women without access to such technology. In the larger context even, urban planners take into consideration the user groups of various ages, community disabled, etc. but there are rare instances of collecting information and consideration for designing women-friendly urban spaces. The only solution for this situation is to develop and initiate a new paradigm of the home, the neighbourhood, and the city to begin to describe the physical, social and economic design of spaces that would support and promote, rather than limit the activities of women.

1.2 Idea: Project Aanandita

Women are looking for self-esteem and opportunities to grow and fully participate in their built environment as a whole part of their community. This can be achieved by developing an inclusive, convenient, and safe city that allows women to fulfil their dreams and goals. Women empowerment occurs when individuals and organized groups can imagine their world differently and realize that vision by changing the relations of power that have kept

them in seclusion, restrained their voice, and denied them of their autonomy.

Taking into consideration the aforementioned problems and aligning with the smart cities' vision, this proposal aims at creating spaces that evoke-affect-inspire women through physical and digital interventions and propose the following:

1.2.1 Gender Integrated Design Approach

The key element of a gender-sensitive approach in the planning dimension, whereby the safety of women in the public spaces is addressed as a component of urban planning and management of public spaces. The call for this consequence formulates an interesting proposition, one that is a common conception – that people's behaviour and, accordingly, the use of spaces is changing – and that this leads to the emergence of Gender-sensitive urban development.

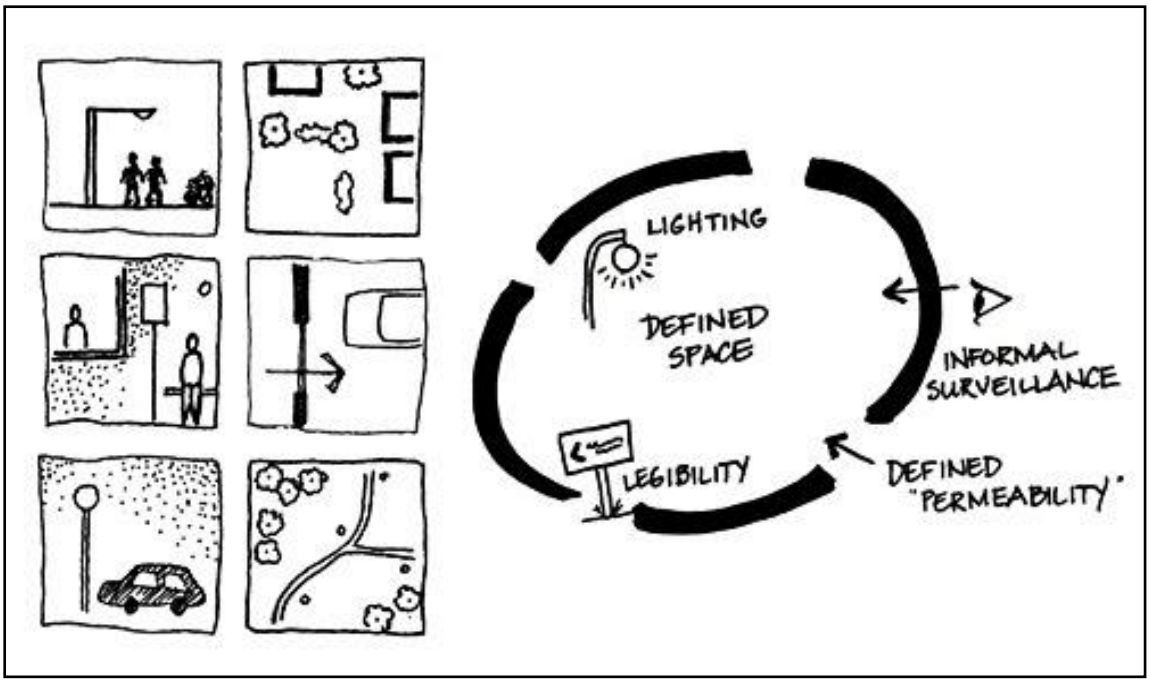


Figure 2: Characteristics of the community-oriented city by Jane Jacob, Eyes of the Street. Source © The Death and Life of Great American Cities, Jane Jacob, 1989

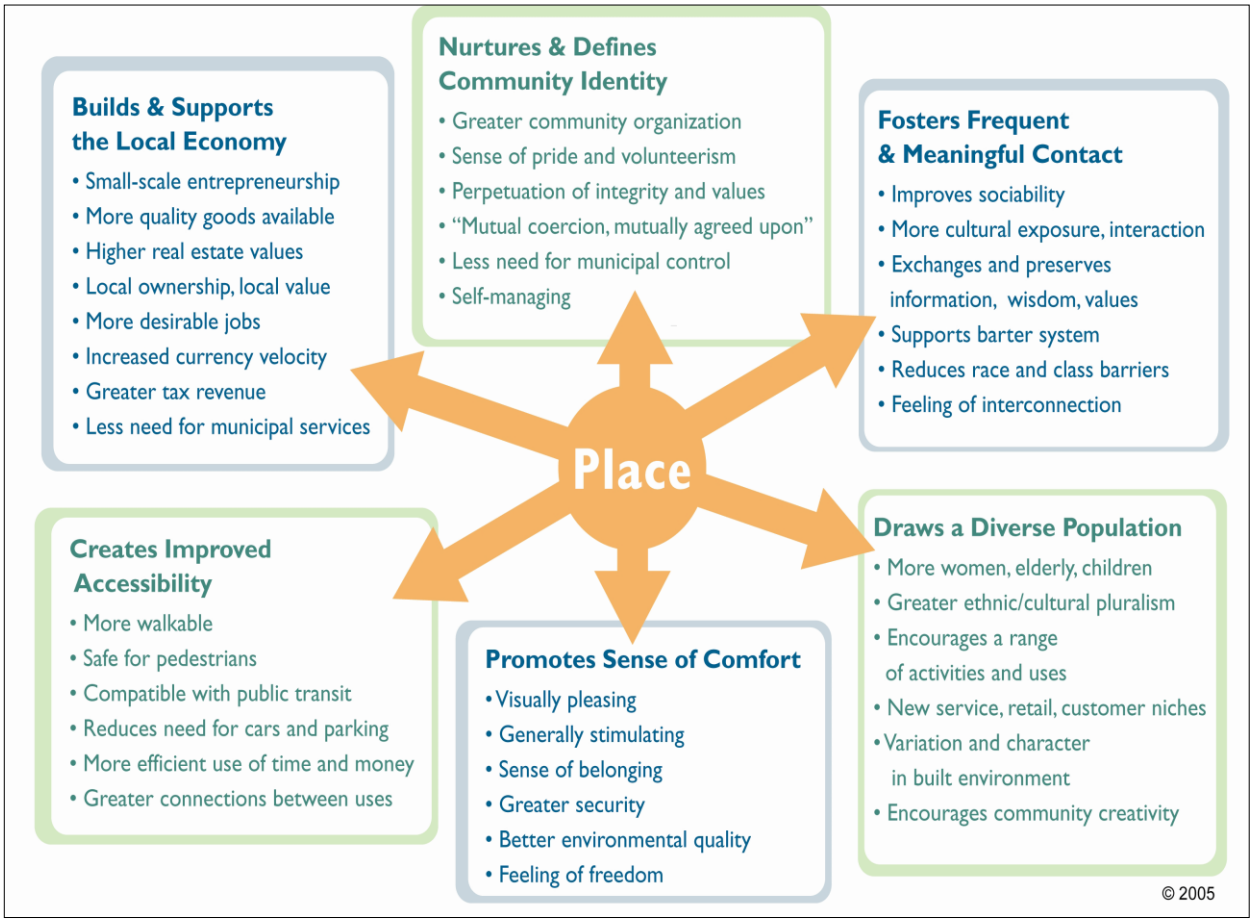


Figure 3: Characteristics of a public place which includes comfort, belonging and commitment. Source © Lehmanandlehman, Place-making

Gender-sensitive development for public spaces can induce psycho-socio, behavioural and cultural changes that can impede their use, appropriation, and safety for its users. Gender analysis is vital to the ability of the built environment to respond to the needs of all who utilize planned spaces. Recognizing the role of gender can be effective in the process of developing gender-sensitive planning strategies. The built environment has a significant influence on the three concepts of safety: comfort, belonging, and commitment.

Figure 3: Characteristics of a public place which includes comfort, belonging and commitment. Source © Lehmanandlehman, Place-making

If your goal is to create a socially engaging space, a design will not be enough. To make an underperforming space into a vital 'place' for all, a physical element must be introduced that would make people, especially women more welcome and comfortable such as sufficient open spaces with landscaping details, through 'management' changes in the pedestrian circulation pattern, clustered development promoting a close-knit society, and by developing more effective relationships between the surrounding retail and the other activities in the public spaces. The goal is to create a place having a strong sense of community and a comfortable image without discriminating against any part of the society.

1.2.2 Promoting Social Dialogues

Local-to-Local dialogues are a powerful medium to enhance local governance and participation of grassroots women in local decision-making by stimulating conversation with local authorities, government departments, NGOs, development partners, the private sector, and the media.

The prevailing lack of awareness, communication, and sharing between systems results in organizations 'reinventing the wheel', duplication of less successful approaches, little guidance for organizations interested in doing effective programming, wastage of precious resources, and ultimately, insignificant change in the lives of women. It is important to strengthen links and connections among organizations working on the concerns related to women's safety and well-being across the world.

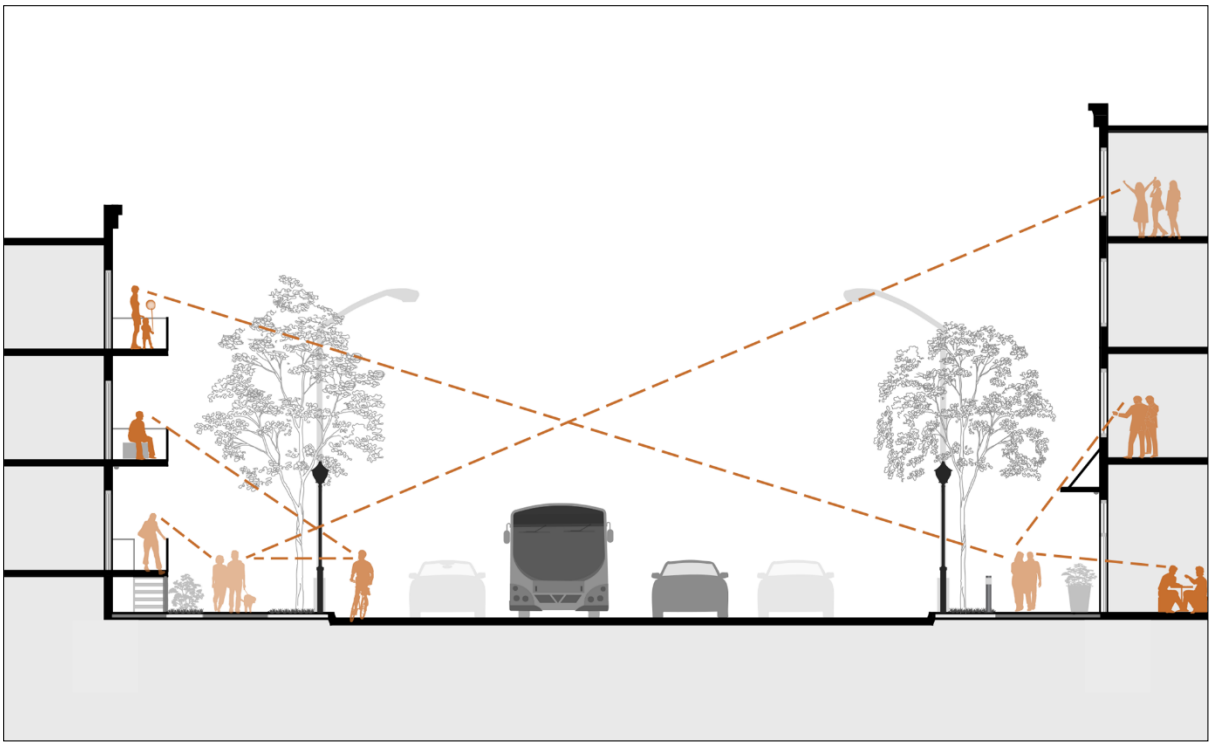


Figure 4: Jane Jacobs Theory, Eyes on the Street. Source © Minneapolis, policies, public-safety-through-environmental-design

Evidence-based research should be used as the foundation for the initiatives, and this should be complemented by the voices of the eventual beneficiaries who should be allowed to identify the problems and challenges they encounter, and for proposing solutions.

Dedicated women-led organizations can be developed at a local level, with the responsibility of consolidating data on women's urban experiences of violence, fear, and exclusion and determining the specific needs of the marginalized group; thereafter providing consulting services to the planning committees regarding gender equality concerns and their vision for the built environment.

1.2.3 Digital Intervention – Nishtha App

Rather than asking women to regulate their movements out of fear of the city, the effort of these gendered movements is to

increase the movement of women, to challenge the hegemony of men over public spaces, and make it more comfortable for women to be present in spaces, which were otherwise uncomfortable in accessing.

Through this proposal, I aim to design a digital app – Nishtha, for women, tourists, and people who are new to an area, and which tells them the safest route instead of the shortest one possible to their destination. The app can also have an option for rating a place based on the user experience. Users can also add their reviews and comments along with pictures, which will assess the environment and contribute to building a safer community. Like google maps can locate the traffic congestion on roads at any given time during the day, this app can depict the footfall in any region and ensure safety and surveillance during the odd hours. The app aims to effectively link diverse stakeholders like Police, NGOs, and organizations working towards women's safety. Through this, women can register complaints and seek help without disclosure of their identity. In case of emergency, instead of a panic button that requires the user to unlock the phone, there can be a speech recognizer which will detect the voice of the user on saying 'Help' and start recording the details of the person in distress automatically. This message will automatically generate a prompt notification on the police systems and a trusted person's phone saved by the user.

To achieve the desired mechanism, identifying the parameters contributing towards the direct impact and the perception of safety is the first step. With the data consolidated for different regions, an algorithm can be developed that provides a scoring based on the available data in a specific region. The algorithm can feed into identifying the safest route for a person, based on the identified factors. The output will not only contribute majorly

towards citizen safety, but it will also help in monitoring the urban nature of a region like lighting and transit routes that can be used by the municipalities, urban designers, architects, and planners for various uses. It can help in improving and monitoring the infrastructural elements along with the direct impact of making places safe.

1.3 Methodology

To ensure gender equality and design women-friendly cities, municipalities must conduct a gender-based analysis to understand the needs of their residents, specifically, women to improve the quality of life.

The analysis is dependent on four steps: Assessment of the situation, Development of the action plan, Evaluation of the plan, and Review of the plan periodically to evaluate its effectiveness.

***Assessment of the situation*: Phase one is envisioned to recognize the demands of women by developing data collection systems based on gender segregation. These developed data collection methods will include surveys and community participation to consolidate the maximum of details specific to men and women and how each uses the urban space. Once sufficient data is available, it is to ascertain difficulties that men and women encounter in the built environment daily and how these factors result in inequalities.**

***Development of the Action Plan*: In Phase two, after the decision-makers have understood the problems and their root causes, comprehensive objectives are formulated to set the long-term goals for the city. Thereafter, the expected outcomes of each step are expressed, and result measuring guides are developed to evaluate the project outcomes. Human and financial resources**

along with the implementation schedule must be predetermined for each procedure. The implementation schedule is meant to allocate responsibilities, set a timeframe for its completion, and ensure communication amongst different stakeholders. It is the blueprint for success with measurable outcomes.

***Evaluation of the Plan*: Phase three includes the evaluation of the project outcomes and their efficacy. To analyze the project's development and the application of guidelines, it is vital to understand the factors contributing to the obstacles in meeting the objectives. As the project progresses, changes may need to be identified for flexible implementation.**

***Review of the Plan*: Phase four includes data being reviewed periodically to assess any changes over time and understand the implications of the project on citizens' lives. This will also include the review of project guidelines and their long-term objectives with the stakeholders to ensure the efficacy of the project.**

1.4 Conclusion

The importance of developing a concept for any gendered public space is to identify the talents and assets within the community. Based on the research done so far, the first step in creating a Gender-Sensitive City is to know the women and girls living there and analyze their needs, problems, and opportunities accurately. Collection of gender-sensitive data to address local inequalities and the political intention to rectify those inequalities will help achieve a gender transformative change.

Inputs from the community and potential partners, understanding how the space works, experimentation and overcoming obstacles provide the concept of space.Although the design is important, the

other elements show you what 'form' is needed to accomplish the future vision for space.

While the scheme is comprehensive, it is not exhaustive nor complete. Therefore, the scheme should be continuously updated and be the foundation for a global platform promoting women's safety within the Smart cities' agenda of promoting inclusive development. These approaches should not be considered as alternatives but should be complementary and parallel.

With a scheme implementable in phases over the years, this idea envisages equality for both men and women, leading to fair-shared, safe, and sustainable cities.

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Shalini is a self-taught artist and her artworks have been displayed at various international forums including WTC The Hague Art Gallery, Netherlands and Bauhaus Prairie Art Gallery.

She loves to travel and discover untold manifestations of design in seemingly mundane life situations as well as natural realms and brings their flavor in her works and mentoring pursuits.

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Delineating the Need of Policy Guidelines for Home Hospitalization/Isolation to Facilitate the Evolving Architectural Paradigm

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Abstract

This paper focuses on identifying the need to evaluate and contextualize the guidelines and policies that inform space design solutions pertaining to home hospitalization in urban residential environments; for all ages and medical conditions.

According to medical research when patients with chronic conditions receive effective health management in an integrated system, with home-treatment support, they recover faster and better. Home hospitalization can reduce the burden on hospitals as well as decrease the cost of care and even prevent development of bacterial resistance due to prolonged hospital stay.

Today technology-enabled healthcare companies are offering sophisticated critical care at home, including advanced facilities like respiratory services, palliative care, cancer support services, post trauma/ accident care and specialized rehabilitation services. This scenario urges to bring all aspects of home hospitalization to the forefront of architectural narratives.

Home Healthcare has characteristics that are very different from those of the hospital. The biggest hurdle that stands in the way is

the dove-tailing of advancements made by medical science with space and services design interventions (provided by architects and designers) so as to enable effective 'hospital-like' care at home.

This paper also takes an integrated look into the domain of home hospitalization in urban Indian context along with reference to global trends. The need identification and evaluation for guidelines and policies in this evolving domain will form the basis for development of requisite space design and planning benchmarks which have become need of the hour, more so, during the current pandemic.

KEYWORDS: ***Home hospitalization, Healthcare Architecture, Home healthcare, Guidelines, Pandemic***

Wellbeing and Healthcare: Hospital-like Care within Home for people of all ages and abilities

Home is a place of comfort and freedom of expression, movement and existence. Home is also a place of solace, healing and recuperating. When it comes to designing a space for a person with disability or limitation owing to age or ill-health, safety, simplicity and adaptability are added parameters to facilitate an effective wayfinding. Patients with chronic conditions requiring long-term care aspire to lead a life of dignity and autonomy, in environs they are most familiar with: their homes. Their progressing age also increases the incidence of disease and disability.

Addressing the issues of healthcare and social needs of a rapidly growing elderly population coupled with medical care of chronic

patients is stretching the limited human and physical resources to their limits. In times of spiraling healthcare costs due to ageing population, growing incidence of lifestyle diseases and the prevailing pandemic, home hospitalization provides an obvious and cost-effective approach to reduce burden on hospitals. It can further decrease cost of care and prevent development of bacterial resistance due to prolonged hospital stay.

According to National Institute for Health and Care Guidelines, a patient's wellbeing may be maintained and enhanced through ensuring a 'sense of being at home' assisted by healthcare technologies by empowering those wishing to age-in-place or otherwise.Rendering hospital like care at home for patients of Alzheimer's, dementia, stroke induced disability, bedridden elderly with physiotherapy needs gives them the ability to age in place with dignity. After all, there is no place like home.

Architect Parul Kumtha who is committed to inclusive architecture in public places and private homes, in an interview (Patients Engage: News and Views, 2020), on her recommendations on design considerations for way forward and future improvement, stated a two pronged agenda – "there needs to be more advocacy and push from persons with disabilities and simultaneously, there needs to be scaffolding and support by way of rules and regulations from the government. Both of these will enable designers to automatically ensure that all design is accessible".

Extending health monitoring from hospital to home environment should not be seen as a replication of the same monitoring procedures and methods of the home environment, because the home environment has characteristics that are very different from those of the hospital in terms of medical facility, human

resources, the medical knowledge of operator, and other factors (Jeong et al., 2012). Thus, the solutions provided for home healthcare need to be devised in order to adapt to change in situations, unforeseen events and newer information.

Global Trends

Recent trends in health care favor alternatives to traditional acute care in hospitals owing to various factors. These include overcrowding of hospitals and emergency departments; rapid advancements in telehealth technologies that enhance the ability of clinicians to observe patients, conduct examinations and exchange information at distance; increased consumer expectations for better care experiences; and pressure from payers to develop high quality, less-expensive alternatives to hospital care. Hospital at-home care, which is generally defined as clinical services provided in association with acute inpatient care in the community, is such an alternative. (Jeff, 2009)

The Centers for Medicare & Medicaid Services (CMS) has outlined unprecedented comprehensive steps to increase the capacity of the American health care system to provide care to patients outside a traditional hospital setting amid a rising number of coronavirus disease 2019 (COVID-19) hospitalizations across the country. These flexibilities include allowances for safe hospital care for eligible patients in their homes (CMS, 2020).

"In March 2020, CMS announced the 'Hospitals Without Walls' program, which provides broad regulatory flexibility that allows hospitals to provide services in locations beyond their existing walls. CMS is expanding on this effort by executing an innovative Acute Hospital Care At Home program, providing eligible hospitals with regulatory flexibilities to treat eligible patients in their homes. This program was developed to support models of at-

home hospital care throughout the country that have seen prior success in several leading hospital institutions and networks, and reported in academic journals, including a major study funded by a Healthcare Innovation Award from the Center for Medicare and Medicaid Innovation (CMMI).” (CMS, 2020).

In many countries, programs in which hospital care is provided in the patient’s own home continue to be a popular response to the increasing demand for acute care hospital beds. Patients who received care through such programs, after assessment in the community by their primary care physician or in the emergency department, may avoid admission to an acute care ward. Alternatively, patients may be discharged early from hospital to receive hospital care at home. (Shepperd et al., 2009).

These programs hinge around providing an alternative to hospitalization, thereby cutting costs, reducing the risk of acquired infections associated with time of stay in hospital and the added benefit of receiving rehabilitation in home environment. In his article, Hagland writes that hospital and health system leaders are responding to the call, and taking advantage of an important opportunity—an opportunity for certain types of patients for whom the healthcare delivery system can effectively care for them better at home, thus improving their individual experiences, as well as conserving on expensive health system resources and improving clinical outcomes simultaneously.These programs also ensure that the care given to patients is tailored to their particular needs and, at the same time, makes life easier for family caregivers.Everyone wins—the patients, the clinicians, the hospitals, and the payers. It could prove to be a significant win in the ongoing shift to value in our healthcare delivery system. (Hagland Mark, 2021)

According to the Emergency Conditions Committee of The Facility Guidelines Institute, New York (FGI, 2021, March) the 2022 FGI Guidelines for Emergency Conditions in Health and Residential Care Facilities will establish new minimum requirements for health and residential care facilities. The intent of this new standard is to provide designers, owners, and authorities having jurisdiction with design requirements and guidance – for new construction and renovation projects – specific to preparedness to meet emergency conditions. The report further states that, "the design of the built environment is a crucial part of establishing a quality of care that promotes safety. Stakeholders involved in the design and construction of healthcare facilities can play an active role in incorporating safety measures into the physical condition of care settings, whether newly constructed or undergoing renovation".

Understanding the Urban Indian Context

For the purpose of this paper, the scope has been limited to demographic data of NCT (National Capital Territory of Delhi). Based on the data given in Draft Master Plan of Delhi 2041 (MPD, 2041) NCT Delhi accounts for about 1.39% of India's population and is also one of the most populous cities in the world. Likely shifts in the demographic profile of the city indicate a significant increase in the proportion of persons in the age group of 60 years and above, signaling the need for specific provisions for the elderly in the Plan. The Plan also acknowledges diversity and works towards creating an inclusive city that facilitates accessibility and opportunity for all.

As per "Apollo Homecare" the geriatric (60 plus) population is expected to grow to 325 million by 2050, doubling from 8.6% in

2011 to 16% by 2041. India currently has around 60 Million diabetics, a number that is expected to swell to 90 Million by 2025.It is also estimated that every fourth individual in India aged above 18 years has hypertension. Lifestyle disorders are on the rise due to a combination of rising incomes, accelerated pace of urbanization and increased life expectancy.

India's hospital bed density is less than half the global average of 3 hospital beds per 1,000 population, implying that an estimated 2.2 Million beds will be required over the next 15 years to meet the growing demand for healthcare. (Sarwal R et al., 2021, March) While the adoption of home healthcare solutions in India is currently at a relatively nascent stage, it has tremendous potential for growth in the future on account of rising elderly population in the country, increase in the incidence of chronic diseases, enhanced demand for constant personalized care as well as the emergence of nuclear family structures in urban areas(Sarwal R et al., March 2021).

Driven by the changing clinical (tele-medicine and tele-diagnostics), economic (increasing per capita income) and societal (nuclear family structure) milieu the demand for healthcare at home is gaining pace.

Hospital in Home

According to NITI Aayog (Sarwal R et al., March 2021) home healthcare is unique not only because care is provided at home, but is also usually less expensive, more convenient, and can be just as effective as the care given in a hospital. Changing consumer mindset is now trending towards comparing healthcare

with other services, with access to healthcare at the place and time of their convenience.

Home Healthcare has characteristics that are very different from those of the hospital in terms of medical facility, human resources, medical knowledge of the operator, availability and maintenance of medical equipment, architectural readiness of areas to be retrofitted and various other factors. This domain still remains largely unaddressed in the Indian context.

The COVID-19 pandemic is likely to provide an impetus to the expansion of the home healthcare market in India. Mitigating the risk of virus spreading to high-risk residents, storage space for oxygen cylinders and concentrators, vertical transport of medical equipment etc. have been challenging issues urging a viable solution. With social distancing established as the new norm and hospital visits becoming riskier; telemedicine solutions are fast emerging as a convenient alternative.

Home healthcare saves on real estate and infrastructure as the model effectively operates at 15%-30% reduced costs in comparison to hospital expenses for similar treatment. It is estimated that home healthcare has the potential to replace up to 65% of unnecessary hospital visits in India and reduce hospital costs by 20%, as per the NITI Aayog report (Sarwal R et al., March 2021).

Many large hospitals are now offering support for post-operative care along with extensive continuum of care at home, including advanced facilities like respiratory services (home ventilation), sleep apnea care, palliative care, cancer support services, post trauma/ accident care and specialized rehabilitation services

(such as pulmonary, neuro, and cardiac rehabilitation; speech therapy). Additionally, end-of-life services are on offer for terminally ill patients as well as personalized care plans formulated in conjunction with doctors. Even the previously unthinkable advanced care such as haemo dialysis and chemotherapy are now making their way into the home healthcare arena.

Challenges: The Role of Architects

Architectural design targets mainly humans, the lives of whom are dynamic and continuously changing. To make building designs more cost-effective, time-effective, energy-effective and function-effective, more careful planning and detailed exploration are needed. Such an informed futuristic planning helps reduce risk, minimize maintenance, optimize solutions, and sustain quality to achieve a balance between the user, client, stakeholders, community, and building goals (Eilouti, 2018).

Maintaining a balance between addressing the health and wellness of the elderly with their need to age with dignity and independence will be one of our biggest social and economic challenges in the years to come. The issue of dove-tailing the advancements made by medical science with design interventions (provided by architects and designers) which enable hospital-like care at home call for an in depth study and analytical outcomes. The evolving architectural paradigm beckons a look into the current and projected requirements over the next decade in the following areas:

- ***Ergonomic requirements to enable safe and hazard free home hospitalization.***
- ***Guidelines for FF&E, surface finishes and materials.***

- ***Evaluation of MEP services to facilitate use of equipment required for critical care and provision of necessary services.***
- ***Inclusive design architecture for differently abled and senior citizens.***
- ***Retrofitting an isolation area in residential setting, while enabling interface for provision of manpower, services and equipment.***
- ***Categorization or typology of homecare depending upon the type and severity of disease/ailment/disability.***
- ***Preparedness of the physical infrastructure.***
- ***Need to mitigate in house accidents by installing better lighting, streamlining floor designs, the inclusion of grab bars and addition of accessible stair climbers.***
- ***Integration of state-of-art systems to hook up home hospitalization with the nearest health care facility for real-time remote monitoring.***

The evolving scenario urges for an interdisciplinary approach to some fundamental questions:

i. ***How prepared are residential premises for delivery of in-place healthcare solutions?***
ii. ***What are the differences in characteristics of home environment from those of the hospital?***
iii. ***What are the demographic and epidemiological trends that are likely to boost the demand for healthcare at home as well as influence the nature of health services in the years to come?***
iv. ***What can be done to retrofit an existing space to function closer to an AII (Airborne Infections isolation) room?***
v. ***What are the cost implications of retrofitting a room to enable home hospitalization?***

Conclusions and Recommendations

The main target of architectural design is the 'User'. During the course of a lifetime, human physiology is ever changing, more often than not, for the worse. Consequently, architecture should be approached dynamically with considerations to address the challenges faced by users of all age groups and abilities.
Furthermore, a shift in the policy agenda is needed from talking about ageing-in-place towards exploring the importance of space and place within the context of ageing-at-home. Relatedly, researchers and practitioners from technology, healthcare and social science cannot continue to work in relative silos. (Creaney R., Reid L. & Currie M., 2021).

Particularly during, and as a result of, the COVID-19 pandemic, there is an urgency for interdisciplinary research to augment the resilience and wellbeing of our communities and ageing populations.

The area of study of architectural interventions for home-hospitalization is relatively new and calls for a comprehensive assessment and in depth study to lead to an initial or preliminary framework to inform the expanding and diversified knowledge base of the topic as it continues to develop.

This paper aims to emphasize and propagate discussion around better understandings of what it means to design spaces that enable delivery of healthcare at home with the help of emerging technologies in the context of ageing and/or recovering at home.
To conclude, time has arrived for developing a comprehensive policy guideline specific to Indian milieu and undertake future research aiming towards encouraging greater debate in the area of home hospitalization/isolation.

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Letter from the Chairman's Desk By Sunil Bhatia PhD

One day I was on an evening walk and found that two teenagers were arguing and in a confronting mood on some matter and to avoid the situation not worsen ,one was touching his throat temple with hand as promising and speaking loudly" I am telling you the truth. If I am found wrong I should die ". Another Youngman trusted his gesture of taking a solemn oath that calmed down his anger and the matter was resolved. Immediately an idea struck to me 'Touching the temple of the throat is a primitive practice for adjuration or confirming or ensuring others whatever I am telling is correct to best of my knowledge and beliefs ?' How did the idea of confirmation by promise or some kind of oath come to exist? Is it the human psyche that needs confirmation? It is modern practice that taking oath by keeping hand on religious book in front of judge in court is one kind of promise that whatever I will give statement will be true , best of my beliefs and knowledge .This exercise is design on keeping the religious fear of an individual that supreme power is witnessing and will punish accordingly in this life or after death if it will prove false.

As I moved further on my walk I observed a driver was changing the punctured wheel of the vehicle and was busy tightening the nut bolts. I questioned myself 'when there is one nut bolt sufficient to hold the wheel of the vehicle why do we have four?' I

realized it is one kind of reassuring the promise and not giving any chance of breaking the promise of one nut bolt rather collective nut bolts hold it best of their efforts and never allow an accident prove fatal .Later on the designer realized that four nut bolts placed in such a way controls the dribbling of the wheel at high speed . In heavy vehicle wheels need special treatment because of heavy load and many number of nut bolts are required and placed in a specific pattern of circle circumference. First design of promise was fulfilled by placing a number of nut bolts for carrying heavy load in the vehicle and later thought of further advantage for meeting other challenges with the same promise.

A gas vendor crossed with a bicycle carrying five cylinders each of 14 kg of gas attached with welded hooks in the carrier. Out of curiosity I went close to him and found that took out one cylinder with an approximate total weight of 50 kgs by simply tilting the bicycle. I observed his centre welded hook of the carrier was with a locking special pin by pushing on hole of hook for the hanging cylinder for placing firmly in its place . I could not resist my curiosity and inquired 'Why did your middle hooks have pins for locking the two placed cylinders on both sides of the carrier ?' He informed me ' Pushing pin locks and fixes the middle cylinder and it controls the jerk of the rest of the cylinder and promises to fix and control pushes of other hanging cylinders .' I admired his design and realized that while cycling some kind of jerk may disturbed the attached cylinder position and the bicycle will misbalance and the possibility of accident was high . That special pin promises the holding of the centre cylinder and rest in return are not experiencing jerk movement.

I came back home and as I pressed the electric switch to start the ceiling fan .I realized that fan design has given me assurance

it will not fall on me. The Ceiling fan needs better assurance of holding the moving fan and nut bolt attached with a ceiling hook has hole for inserting the pin. Pin promises rotating fans may lose the nut bolt but placing of pin that is not affected with vibration promises us of holding the nut bolt with hook.

I was working on the computer in my office and as I pressed the button of the mouse a question flashed on screen. 'Do you want to delete it permanently?' I was on alert mode . Is it not one kind of promise needed by service providers by raising such questions? Once selected action is taken, the responsibility of the service provider is no more questionable.

In the initial days of shoe design there was no lace and sandal or pump shoes were designed for just slip in the feet and the entire promise of holding was on the upper of the shoe. This design was infeasible at the time of running fast or walking because it fails to hold the promise of proper holding in feet and chances of tripping or some kind of hindrance appears in fast motion. A special design of holding with laces surfaced that helps in fulfilling promises but placing the eyelets in specific style was completely designer's job. A walking shoe has fewer eyelets for laces compared to running shoes. Is it not one kind of promise of introduction of laces in shoes?

In primitive times people were tying the bundle of tinders or logs with rope for carrying from one place to another. That rope strength was deciding the nature of promise. If it is a weak rope , the bundle should be designed small for keeping the promise of holding together .Human body can promise to hold the small bundle by hand and carrying it was a difficult exercise for transportation. Someone found that holding by hand is failing then

the idea of tying surfaced. When a man holds the hand of opposite sex it assures of protections. Verbal assurance came much later and writing assurance is a recent phenomenon. Similarly loose papers were tied with thread and later on with staplers. Design of screws or nut bolts or rivets are extensions of the promise of holding together . Design of chair assures us that it can hold the weight of the sitting person and it will be comfortable also. Button, hooks, zip are all designed with the promise of holding the dress in what way the designer has designed. Design of receipt is a kind of promise and a form of agreement signed between seller and purchaser and transaction has taken place.

Design of the finger ring is another example where it promises that it will not come out even if some jerk of hand is applied. It has no elasticity of metal for holding into fingers, rather it is designed by using knots of joints of finger for not slipping out of finger. The size of joints decides the size of the ring for promising of not coming out easily. 'What is the promise in design?' A designer designs the product/ services for meeting specific objectives and through design promises it will function for what it is designed for. Design of knots promises that both ends of two ropes are joined and if there is a possibility of breaking the promise that means single knots is not enough for holding promise and applies multiple knots for not to break promise.

In ancient times the promise was in different forms where mutual respect but the nonverbal promise was widespread. Their prime was hunting so the promise was around that. When an individual was failing in overpowering the wild animals, he himself turned out to be prey. He thought of making himself powerful and invited the people for hunting and one kind of promise was there of sharing the foods in any form of participation in killing prey. As people realized some could not

participate in hunting either age factor was not permitting or physical strength or organs were failing and they would prove liability on hunting groups and keep them away by saying your share will be protected and delivered . It was one kind of promise. This idea is extended further and turns out to be paper currency. The design of paper currency has come to the existence where the state promises the owner for the value and someone refuses for acceptance is a punishable act.

The idea of a door has a different concept from the ventilator. Door is designed for dual purpose of welcoming the desire person and stop the intruders.Ventilators were designed for free entry of sunlight and air in the room but the possible intruders is controlled by making small passage at the height of the wall close to the roof that creates high level of discomfort and does not allow unwanted entry and it is made at the height of the wall close to the roof. The door's purpose is to welcome the desired person without any discomfort. A door without latches or locks has no purpose and it is the weakest point in the entire door design. Hinges are designed for holding and motion of door panel but it is designed to be concealed in the panel and no intruder can attack that area without special assistance. The design of lock and key has resolved this issue and given a promise to the owner that in absence I will protect assets from intruders. It cannot keep promise if latches or locks fail in keeping promise of not allowing intruders. The concept of the private key and the public key has come to the existence of promising the welcome of person who holds the real one, otherwise treated as intruders. In the modern era of the digital world, a safe message has public and private keys and it is an extension of the door where open-access information is like ventilators.

I am thankful to Prof Mandeep Singh for making such a great effort in a very short time for the special issue of September 202 Vol-16 No-9. His retirement from School of planning and Architecture is on 30th October 2021 . His contribution for students and academics is valuable and I hope he will contribute the same after retirement.

Lambert Academic publication for celebration of 150th special issue by publishing a book by compiling editorials "Design For All, Drivers of Design" translated in eight different languages from ENGLISH into French, German, Italian, Russian, Dutch and Portuguese. Kindly click the following link for book. "Morebooks", one of the largest online bookstores. Here's the link to it:

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With Regards

Enjoy reading, be happy, and work for the betterment of society.

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Forthcoming Issues

October 2021 Vol-16 No-10

***Jane Bringolf** is Chair of Centre for Universal Design Australia (CUDA), a registered charity seeking a more inclusive world. She wants to see a world where designers and policy makers automatically consider the diversity of the population and create inclusive built environments, products, services, and communications. Her passion for the topic is based on forty years working in the community sector. She writes regularly on universal design and inclusive practices and curates the weekly newsletter for CUDA. Jane also contributes to various advisory panels and education sessions on universal design. Jane holds a BSSc, MBA and PhD and is also a Churchill Fellow.*

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Africa Origin Designer year 2021
December 2021 Vol-16 No-12

Ricardo Gomes, IDSA

Professor Ricardo Gomes has been a faculty member in the School of Design at San Francisco State University for over 29 years. He was the Chair of the DAI Department from 2002-2012.

Prof. Gomes coordinates the Design Center for Global Needs and the Shapira Design Archive Project in the School of Design (DES).

This non-profit international research and development center is dedicated to promoting responsive design thinking methods and solutions to local, regional and global issues such as: inclusive/universal design, health care, the aging, community development, social innovation and sustainability of the built environment.

Prof. Gomes was awarded the 2020 Faculty Award for Excellence in Service Learning, from the Institute for Civic and Community Engagement, SFSU; and the IDSA 2020 Education Award presented in recognition of significant, distinguished, and long-term contributions of faculty to the field of industrial design academia

Prof. Gomes is on the Board of Directors of the Institute for Human Centered Design in Boston. He is also a member of the Industrial Designers Society of America; and Trustee of the Beta Beta Chapter, Epsilon Pi Tau International Honor Society for Technology in the School of Design, SFSU. Prof. Gomes was a Fulbright Research Scholar from 1984-1986 at the University of Nairobi,

Kenya. He conducted post-graduate research and product development of a container system for mobile health care delivery in East Africa from 1982 – 1987. In 1986, he was Program Coordinator of Design Projects in Developing Countries, Les Ateliers, Ecole nationale supérieure de création industrielle (ENSCI) in Paris, France where he directed student liaison projects with European international development agencies.

For over 30 years, Prof. Gomes has conducted keynote speeches, presentations, symposiums and workshops at universities and international conferences throughout Africa, Asia, Europe, Latin America and the U.S. In addition, he has served on juries related to Inclusive Design; Universal Design; Design for Social Responsibility; Sustainability; and Equity for BIPoC in the Built Environment.

Prof. Gomes received his MFA in Industrial Design for Low-Income Economies from the University of California, Los Angeles (Design of a Container System for Mobile Health Care Delivery in East Africa). He received an M.A. in Architectural Building Technology from School of Architecture and Urban Planning at UCLA (Analysis of Alternative Building Materials and Construction Systems for Small-scale Industries in the Cape Verde Islands, West Africa); and a BFA in Industrial Design from Massachusetts College of Art (Design of an Adaptive Structural Environment for Severely Disabled and Developmentally Challenged Children).

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Doctor in Engineering with cum laude honors, with more than 30 years' experience working in the field of accessibility. From 1990 to 2000, I was as an accessibility consultant specializing in protected natural areas. On 2000, I was appointed General Director and CEO of accessibility consultant company, Via Libre, until 2003 when I became Director of Universal Accessibility and Innovation Directorate at Fundacion ONCE to present. I am currently vice president of the European Network of Accessible Tourism (ENAT), president of the technical standardization committee 170 for Universal Accessibility and Design for All, and a trustee of three foundations working in accessibility. I have also been a jury member of the following awards: Access City Awardsfrom its first edition to present, Queen Letizia Awards, Fundación Universia Innovation Awards and OTIS Accessibility Awards. Additionally, I have been Project Leader of several standardization working groups about accessibility such as European Commission Mandate 420, Accessibility Requirements for Public Procurement and ISO 21902 Accessible Tourism. Moreover, I have been dissertation director and a member of the examination committee for more than ten doctoral dissertations, co-author of over 80 research papers and publications, and have travelled to more than 30 countries to participate at conferences a guest speaker. I have also received additional training at some of

the most prestigious universities such as Polytechnic University of Madrid, Stanford University, London School of Economics and IESE

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it is available on **www.morebooks.de** one of the largest online bookstores. Here's the link to it:
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Rosemarie Rossetti, Ph.D., teamed with her husband Mark Leder in creating this unique Toolkit. They bring ten years of research, design and building expertise by serving as the general contractors for their home, the Universal Design Living Laboratory– which is the highest rated universal design home in North America.

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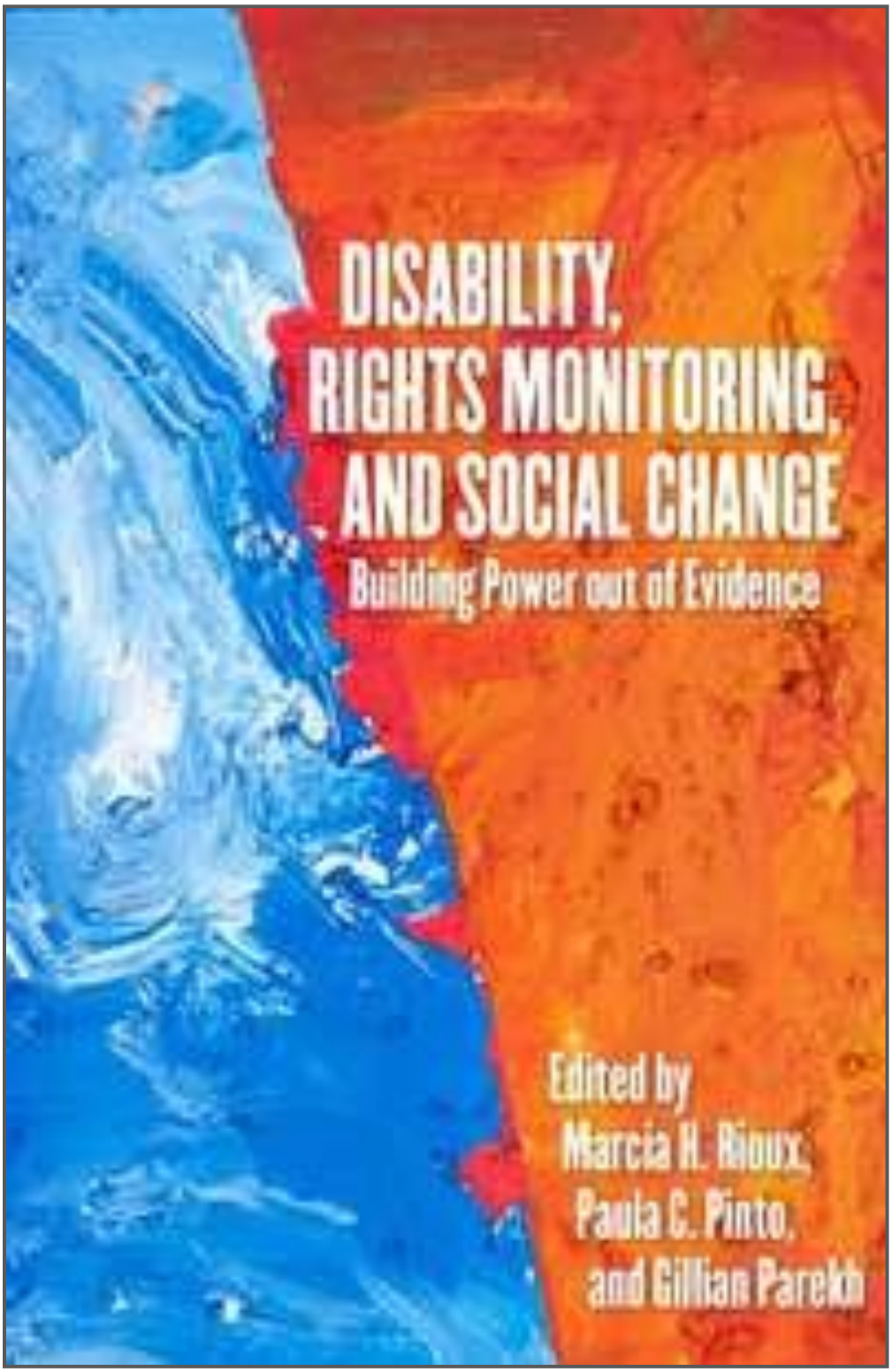

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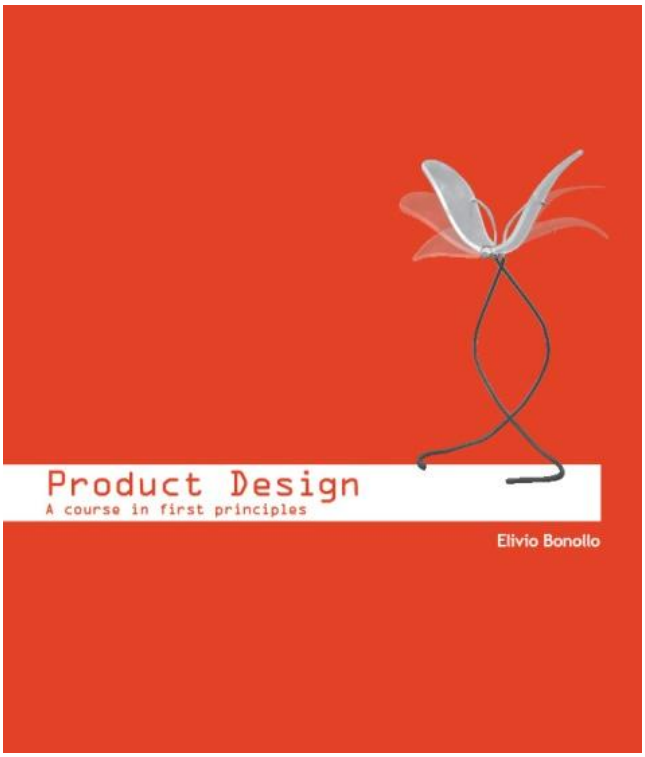

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READING HINTS: ePub files can be read with the iBook app on Apple MacBook/iPad devices; ePub files can also be read on Desktops PCs, Laptops and Surface devices using readers such as the Microsoft *freda*ePub reader. The Kindle (mobi file) reader isflexible and suitable for reading the eBook on PCs; Kobo readers can also be used to read ePub files on MacBook and iPad. All formats are very interactive with very good navigation.

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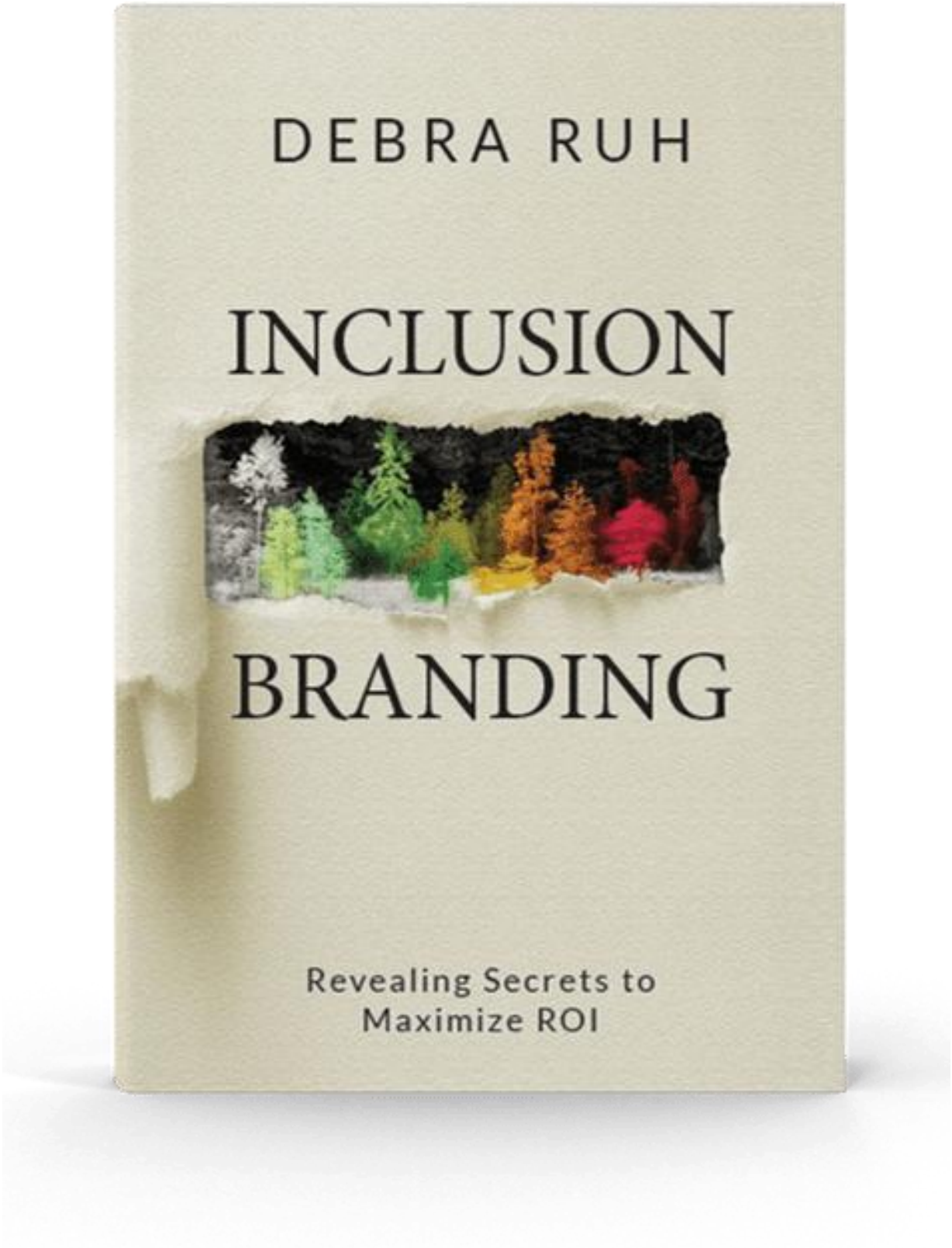
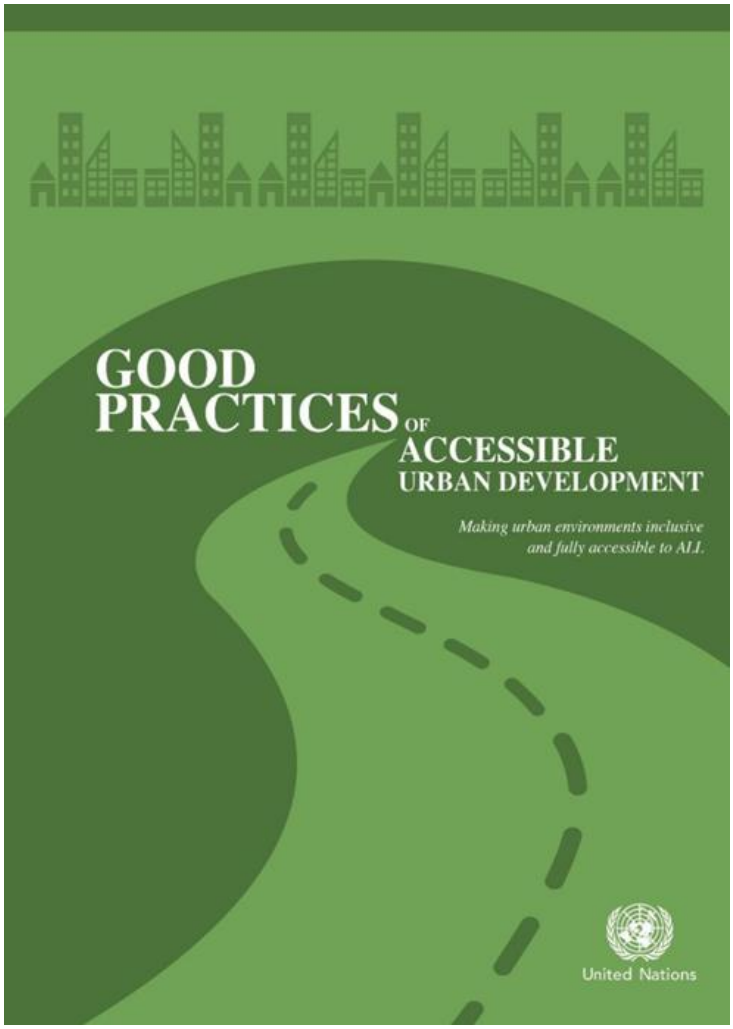
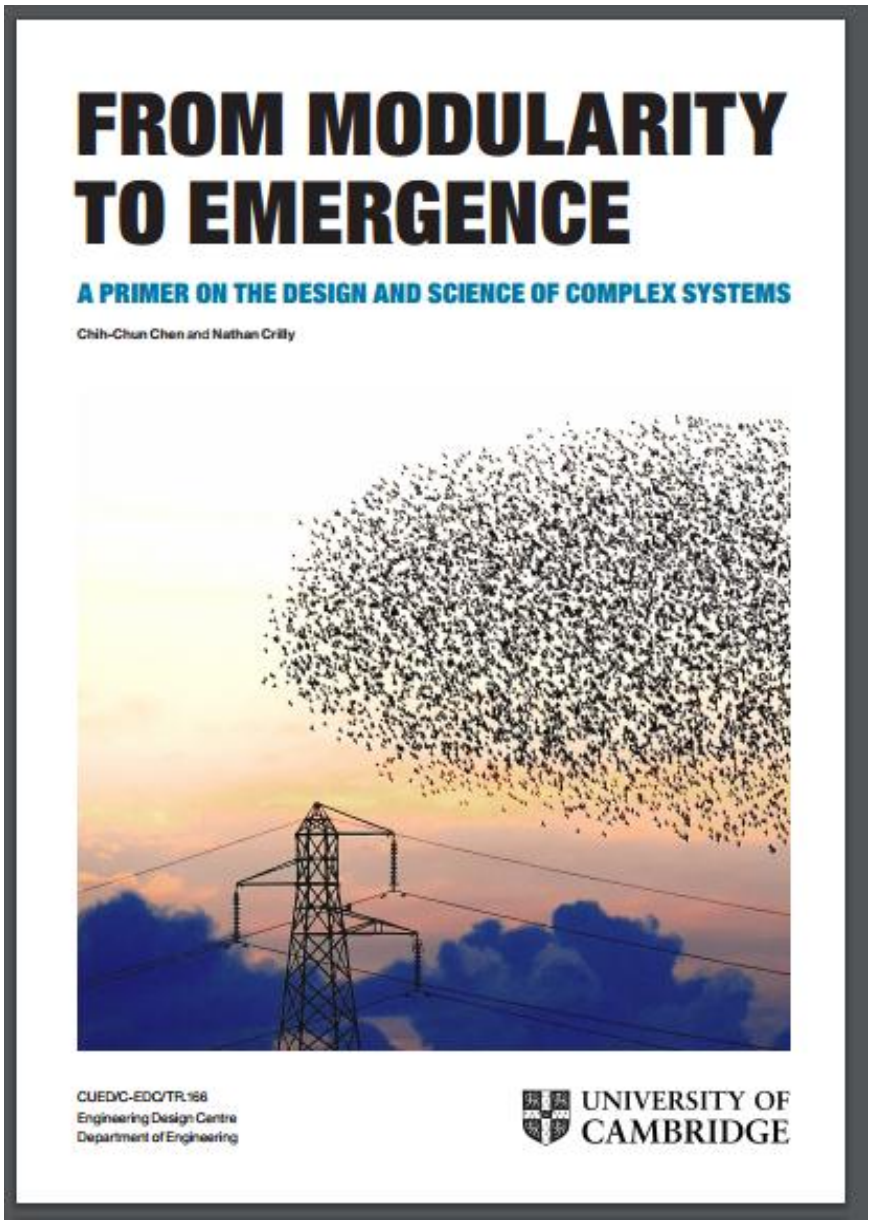




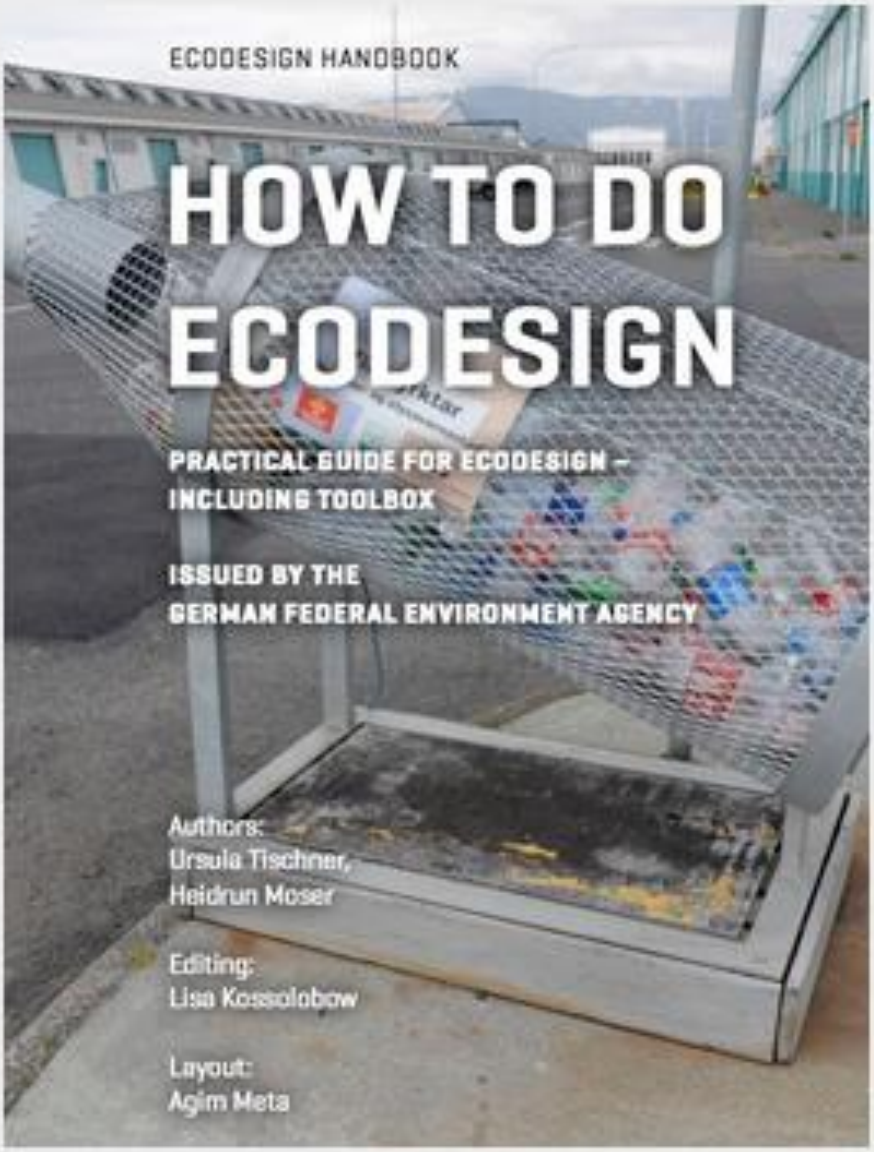
In light of the forthcoming United Nations Conference on Housing and Sustainable Urban Development (HABITAT III) and the imminent launch of the New Urban Agenda, DESA in collaboration with the Essl Foundation (Zero Project) and others have prepared a new publication entitled: "Good practices of accessible urban development".
The publication provides case studies of innovative practices and policies in housing and built environments, as well as transportation, public spaces and public services, including information and communication technology (ICT) based services. The publication concludes with strategies and innovations for promoting accessible urban development.
The advance unedited text is available at:http://www.un.org/disabilities/documents/desa/good_practices_urban_dev.pdf



Dr Chih-Chun Chen and Dr Nathan Crilly of the Cambridge University Engineering Design Centre Design Practice Group have released a free, downloadable book, _A Primer on the Design and Science of Complex Systems_.
This project is funded by the UK Engineering and Physical Sciences Research Council (EP/K008196/1).
The book is available at URL: http://complexityprimer.eng.cam.ac.uk

Changing Paradigms: Designing for a Sustainable Future

New iBook / ebook:
HOW TO DO ECODESIGN



Practical Guide for Ecodesign – Including a Toolbox
Author: Ursula Tischner

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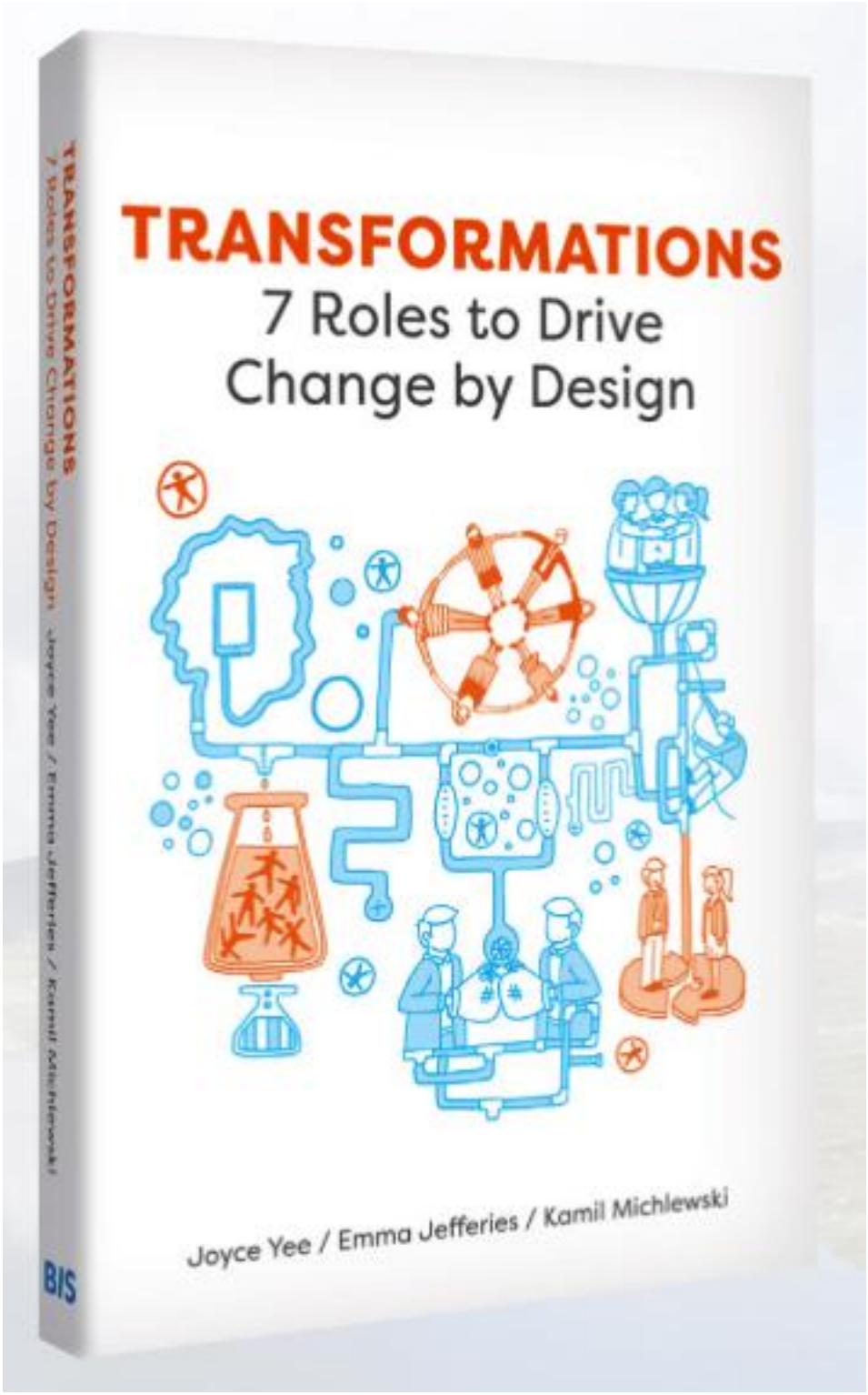
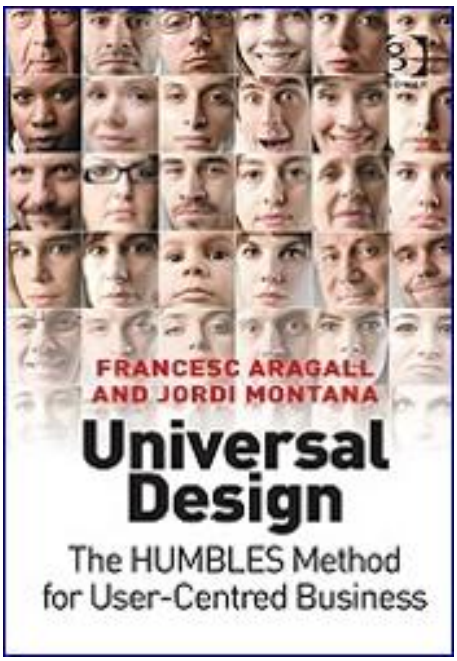


Universal Design: The HUMBLES Method for User-Centred Business



"Universal Design: The HUMBLES Method for User-Centred Business", writtenbyFrancescAragall and JordiMontañaandpublishedbyGower, providesaninnovativemethod to supportbusinesseswishing to increase the number of satisfiedusersand clients andenhancetheirreputationbyadaptingtheirproductsandservices to the diversity of their actual andpotentialcustomers, takingintoaccounttheirneeds, wishesandexpectations.

The HUMBLES method (© Aragall) consists of a progressive, seven-phaseapproach for implementing Design for All within a business. Byincorporating the user'spoint of view, itenablescompanies to evaluatetheirbusinessstrategies in order to improveprovideanimproved, morecustomer-orientedexperience, andtherebygain a competitiveadvantage in the marketplace. As well as a comprehensiveguide to the method, the bookprovidescasestudies of multinationalbusinesswhichhavesuccessfullyincorporated Design for All intotheirworkingpractices.

According to SandroRossell, President of FC Barcelona, who in company withotherleadingbusiness professionals endorsed the publication, it is "requiredreading for thosewhowish to understandhow universal design is the onlyway to connect a brand to the widest possible public, increasing client loyaltyandenhancing company prestige". To purchase the book, visiteither the **Design for All Foundation website**

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Appeal

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News

1.

Study of Design needs practical lab sessions

While stakeholders are continuing education in the field, they are waiting for offline classes to begin in earnest

Representative Image. (Getty Images)

Today, a hybrid format of teaching-learning is being hailed as the future of education. However, in the case of courses such as Design, which requires regular lab sessions and practical hands-on training, students and teachers are waiting to restart offline classes.

Praveen Nahar, director, National Institute of Design, Ahmedabad, says, "Over the course of the pandemic, the institute adopted a hybrid mode with remote facilitation leveraging learner's own context, remote access to institutional resources and more.

Whenever the situation was better, we also provided optional access to workshops/studios/labs."

Aditi Srivastava, president, Pearl Academy, New Delhi, explains, "With a shift to the hybrid concept, the aim was to ensure that students do not miss out on experiential learning. Many practical concepts, such as drafting a pattern, were taught through online classes. If students did not understand anything, they were supported with recordings of live lectures as well."

The last eighteen months have reshaped the way various Design modules were taught, says Manisha Mohan, dean, School of Design, University of Petroleum and Energy Studies (UPES), Dehradun. "The initial time went in guiding students and teachers to get comfortable with online classes. We also used Coursera to help students with additional material," she adds.

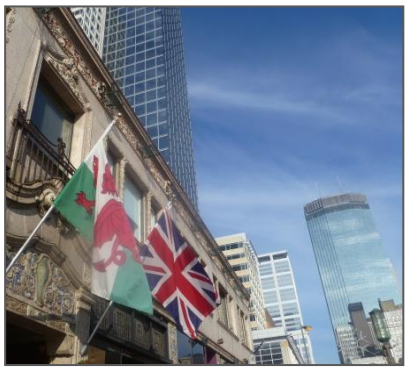
Dealing with challenges

Nahar says that the shift has been a challenge for both teachers and learners. "The hybrid concept pushed us to re-exam our pedagogy and develop new assignments/teaching methodologies within the constraints. Innovative use of technology led to increased levels of re-skilling for all," he says.

A big issue was to provide students with adequate practice material at home, says Srivastava. "During the lockdowns, even online delivery of relevant raw material had not been possible. Thus, we sent tool kits to each of our student's homes to enable them to continue practical learning," she says.

(Courtesy: Times of India)

Programme and Events



Conferences / 2021 / August 2021 in London / Inclusive Design and Manufacturing

ICIDM 2021: 15. International Conference on Inclusive Design and Manufacturing

August 19-20, 2021 in London, United Kingdom

UD 2021

A! Aalto University

FIFTH INTERNATIONAL CONFERENCE ON UNIVERSAL DESIGN

June 9 - 11 2021 at Aalto University, Espoo

GET READY TO CELEBRATE GREAT DESIGN!

As restrictions start to ease across Australia we can't wait to celebrate the very best in design and innovation with our 2021 Good Design Award Winners. Booked for Fri 17 September at The Star in Sydney, this year's Good Design Awards Ceremony will be one you don't want to miss!

We think our design community deserves an extra special celebration this year, so save the date and get your entries in!

ENTER GOOD DESIGN AWARDS

INTERIOR DESIGN CONFEDERATION SINGAPORE

IDCS Design Excellence Awards 2021

Mar 27, 2021 2:27 am EDT

The Interior Design Confederation Singapore (IDCS) is calling for entries for its 2021 Design Excellence Awards.

The leading awards program showcases the best interior design talent in Asia-Pacific.

The deadline for submissions is August 31, 2021.

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Sixth International Conference on Universal Design

September 7-9 2022 - Brescia, Italy

The UD2022 conference is co-organized by University of Brescia, Ca' Foscari University of Venice and University of Trieste, Italy.

This sixth conference in a series of major biennial international conferences on Universal Design: UD2012 (Oslo), UD2014 (Lund), UD2016 (York), UDHEIT2018 (Dublin), UD2021 (Helsinki) is the first one to be organized in southern Europe.

The conference is targeted at professionals and academics interested in the theme of Universal Design related to the built environment and users' wellbeing. The themes cover also mobility and urban environments, knowledge, and information transfer. The conference provides research knowledge and best practices from all over the world.

UNIVERSITY OF BRESCIA

UNIVERSITY OF TRIESTE

Ca' Foscari University of Venice

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23rd International Conference on Engineering & Product Design Education (E&PDE 2021)

VIA Design, VIA University in Herning, Denmark

Workshops and Registration: 8th September 2021

Conference: 9th & 10th September 2021

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Job Openings

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